Honeywell Bull

TIME-SHARING APPLICATIONS LIBRARY GUIDE VOLUME III - INDUSTRY ADDENDUM A

SERIES 600/6000

APPLICATIONS

SUBJECT:

Additional and Revised Time-Sharing Programs.

SPECIAL INSTRUCTIONS:

This update is the first addendum to DA45, Revision 2, dated December 1972. Sixteen new programs and nine revised programs are being added with this addendum; these programs are listed in the revised Preface.

Insert the attached pages into the manual as indicated in the collating instructions on the back of this cover. Change bars in the margins indicate new and changed information; asterisks denote deletions.

NOTE: This cover should be inserted following the manual cover to indicate the updating of the document with Addendum A.

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DA45A, Rev. 2

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COLLATING INSTRUCTIONS

To update the manual, **remove old pages and insert** new pages as follows:

Remove	Insert
Title/Preface	Title/Preface
iii/iv	iii/iv
vii through xii	vii through xiii, blank
MS-11 through MS-16	MS-11 through MS-16 MS-16.1 through MS-16.3, blank
MS-23 through MS-26	MS-23 through MS-26
MS-39 through MS-42	MS-39 through MS-42
MS-43 through MS-48	MS-43 through MS-48 MS-54.1/MS-54.2
MS-61 through MS-63	MS-61 through MS-63, blank MS-86.1 through MS-86.5, blank
MS-91 through MS-99	MS-91 through MS-100
	GP-6.1 through GP-6.3, blank
ED-1/ED-2	ED-1 through ED-2.1, blank
ED-3/ED-4	ED-3/ED-4
ED-5/ED-6	ED-5/ED-6
DE-3/DE-4	DE-3/DE-4 DE-4.1 through DE-4.3, blank
	UM-0.1 through UM-02
	UM-2.1, blank UM-2.3 through UM-2.4 UM-2.5 through UM-2.7, blank UM-2.9/UM-2.10 UM-2.11/UM-2.12 UM-10.1/UM-10.2 UM-10.3/blank UM-12.1 through UM-12.3, blank UM-12.5, blank UM-23, blank

File No.: 16R3, 17R3

Republique Copie 9-73

DA45A

In addition, several existing programs are revised to run on Series 6000 FORTRAN. These programs include:

CPM
GASPIIA
INT01
INTLP
LNPROG
TCAST
DRIVES
EXPERn
PREPRS

A complete printing of the programs in the library is available by listing the library program, CATALOG. A copy of this listing follows the Contents.

Other Series 600/6000 Time-Sharing Library programs are described in the following documents:

Series 600/6000 Time-Sharing Applications Library Guide, Volume I - Mathematics, Order Number DA43

Series 600/6000 Time-Sharing Applications Library Guide, Volume II - Statistics, Order Number DA44

Series 600/6000 Time-Sharing Applications Library Guide, Volume IV - Business and Finance, Order Number DA46

Series 600/6000 Time-Sharing Applications Library programs are also available to users of the DATANETWORK service. Please contact your local Honeywell representative for further details.

This document describes programs that originated from a variety of sources, such as users and the Honeywell field organization. The programs and documentation are made available in the general form and degree of completeness in which they were received. Honeywell Information Systems Inc., therefore, neither guarantees the accuracy of the programs nor assumes support responsibility.

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CATALØG ØF SERIES 6000/600 T-S LIBRARY PRØGRAMS

FILE TYPE INDICATØR:

LANGUAGE (FIRST LETTER)		MØDE (FØLLØWING LETTERS)	
A	ALGØL	P	(ØR BLANK) PRØGRAM
B	BASIC	S	SUBRØUTINE(S)
C	CARDIN	F	FUNCTIØN(S)
D	DATABASIC	P-S	PRØGRAM WITH EXTRACTABLE SUBRØUTINE(S)
E	TEXT EDITØR	R	RELØCATABLE ØBJECT (C*)
F	FØRTRAN	H	SYSTEM LØADABLE ØBJECT (H*)
G	GMAP	L	USER'S RANDØM LIBRARY

ALL FILES ARE SØURCE MØDE UNLESS ØTHERWISE INDICATED.

SUBJECTS	DØCUMENTATIØN MANUAL
MATHEMATICS (MA)	ØRDER # DA43
INTEGRATIØN	
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BUSINESS AND FINANCE (BF)	ØRDER # DA46

THE DØCUMENTATIØN FØR THESE PRØGRAMS IS AVAILABLE IN FØUR MANUALS:
SEE ØRDER # DA43 FØR PRØGRAMS IN MATHEMATICS
ØRDER # DA44 FØR PRØGRAMS IN STATISTICS
ØRDER # DA46 FØR PRØGRAMS IN BUSINESS AND FINANCE
ØRDER # DA45 FØR PRØGRAMS IN ALL ØTHER CATEGØRIES.

SUBRØUTINES THAT ARE CALLED BY A PRØGRAM AND MUST BE EXECUTED WITH IT ARE LISTED IN BRACKETS AT THE END ØF THE DESCRIPTIØN.

THESE PRØGRAMS HAVE ALL BEEN REVIEWED AND TESTED BUT NØ RESPØNSIBILITY CAN BE ASSUMED.

**********MA--MATHEMATICS**********

INTEGRATIØN

CLCINT	FF	INTEGRATIØN BY SIMPSØN'S RULE
FINT	FF	EVALUATE FØURIER INTEGRALS BY FILØN'S FØRMULA
GAHER	FF	GAUSS-HERMITE QUADRATURE
GALA	FF	GAUSS-LAGUERRE QUADRATURE
GAUSSN	FF	EVALUATE DEFINITE DØUBLE ØR TRIPLE INTEGRALS
GAUSSQ	FF	GAUSSIAN QUADRATURE
NCØATES	FP-S	NEWTØN-CØATES QUADRATURE
NUMINT	B	GAUSSIAN QUADRATURE
RØMBINT	FP-S	RØMBERG INTEGRATIØN
SPLINE	B	INTEGRATE TABULATED FUNCTIØN BY SPLINE FITS

DIFFERENTIATIØN, DIFFERENTIAL EQ.

AMPBX	FS	ADAMS-MØULTØN FØR 1ST-ØRDER DIFF. EQNS [RKPBX]
FDRVUL	FF	DIFFERENTIATE TABULATED FUNCTIØN, UNEQUAL SPACING
HDRVEB	FF	DIFFERENTIATE TABULATED FUNCTIØN, EQUAL SPACING
RKPBX	FS	RUNGE-KUTTA FØR 1ST-ØRDER DIFF. EQNS

***INTERPØLATIØN*

SPLINT	B	SPLINE INTERPØLATIØN
TNT1	FF	SINGLE LAGRANGIAN INTERPØLATIØN [TLU1]
TNT2	FF	DØUBLE LAGRANGIAN INTERPØLATIØN [TLU1]
TNT2A	FF	VARIABLE DØUBLE LINEAR INTERPØLATIØN [TLU1]

PØLYNØMIALS

BICØF	FS	CALCULATE BINØMIAL CØEFFICIENTS
CLPLY	FF	EVALUATE REAL PØLY AT REAL ARGUMENT
CPØLY	FS	FINDS ZERØES ØF A CØMPLEX PØLYNØMIAL
CPØLY-DR	FP	FINDS ZERØES ØF A CØMPLEX PØLYNØMIAL [CPØLY]
DVALG	FS	PØLYNØMIAL DIVISIØN
EUALG	FS	G.C.D. ØF TWØ PØLYNØMIALS [DVALG]
MTALG	FS	MULTIPLY PØLYNØMIALS
PLMLT	FS	REAL PØLY CØEFFICIENTS RECØNSTRUCTED FRØM REAL RØØTS
PØLRTS	FP	SØLUTIØN ØF PØLY BY BAIRSTØWS METHØD
PØLYC	FS	REAL PØLY CØEFFICIENTS RECØNSTRUCTED FRØM CØMPLEX RØØTS
PØLYV	FS	EVALUATE REAL PØLY AT CØMPLEX ARGUMENT
QUADEQ	B	SØLUTIØN TØ QUADRATIC EQUATIØNS
RØØTER	B	SØLUTIØN ØF PØLY BY BAIRSTØWS METHØD
ZCØP	FP	RØØTS ØF PØLYNØMIAL WITH CØMPLEX CØEFF.
ZCØP2	FS	RØØTS ØF PØLYNØMIAL WITH CØMPLEX CØEF. [ZCØP2]
ZØRP	FP	RØØTS ØF REAL PØLY
ZØRP2	FS	RØØTS ØF REAL PØLY

LINEAR EQUATIØNS

GJSIMEQ	FS	SØLVE LINEAR SYSTEMS BY GAUSS-JØRDAN
GSEIDEL	FP-S	SØLVE LINEAR SYSTEMS BY GAUSS-SEIDEL
LINEQ	FS	SØLVE LINEAR SYSTEMS BY GAUSSIAN ELIMINATIØN
LINSR	FP	SØLVE LINEAR SYSTEMS BY GAUSSIAN ELIMINATIØN [LINEQ]
SIMEQN	B	SØLVE LINEAR SYSTEMS BY MATRIX INVERSIØN

MATRICES

DETE	FF	EVALUATE DETERMINANT ØF REAL MATRIX
DØMEIG	FP-S	DØMINANT EIGENVALUES ØF REAL MATRIX
EIG1	FS	EIGENVALUES ØF SYM MATRIX BY JACØBI METHØD
EIGNHC	FS	EIGENVALUES & VECTØRS ØF CØMPLEX NØN-HERMITIAN MATRICES
EIGNSR	FS	EIGENVALUES & VECTØRS ØF REAL NØN-SYMMETRIC MATRICES
EIGSR	FP	EIGENVALUES AND VECTØRS ØF REAL SYM. MATRIX [EIG1]
LINSD	FS	SØLVE LIN. SYS. W/ SYMMETRIC DØUBLE PREC. CØEF. MATRIX
LINSS	FS	SØLVE LIN. SYS. W/ SYMMETRIC SINGLE PREC. CØEF. MATRIX
MTINV	FS	MATRIX INVERSIØN BY PIVØTS
MTMPY	FS	MATRIX MULTIPLICATIØN
MTRAN	FS	TRANSPØSE A MATRIX
SPEIG1	FS	SPECIAL EIGEN PRØBLEMS [EIG1]
SYMEIG	FP	EIGENVALUES ØF SYM MATRIX BY JACØBI METHØD

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***NØN-LINEAR EQUATIØNS***
BRØWN      FS     SØLN ØF SIMULTANEØUS SYSTEMS BY BRØWN METHØD
SECANT     FS     SØLN ØF SIMULTANEØUS SYSTEMS BY SECANT METHØD (MTINV)
SØLN       FF     ZERØ ØF AN ARBITRARY FUNCTIØN
ZERØES     B      ZERØ,MAX,MIN ØF FUNCTIØN

***SPECIAL FUNCTIØN EVALUATIØN*
                                **
ARCTAN     FF     ARCTANGENT IN RADIANS ØF Y/X
BESL       FS     BESSEL FUNCTIØN (GAMF)
CØMP1      FF     EVALUATES REAL HYPERBØLIC TRIG FUNCTIØNS
CØMP2      FS     CØMPLEX MULT. AND DIVISIØN
CØMP3      FS     EVALUATES VARIØUS FUNCTIØNS FØR CØMPLEX ARGUMENT (CØMP2)
ERRF       FF     ERRØR FUNCTIØN
ERRINV     FF     INVERSE ERRØR FUNCTIØN
FRESNL     FS     EVALUATES FRESNAL INTEGRALS
GAMF       FF     GAMMA FUNCTIØN
JACELF     FS     EVALUATES JACØBIAN ELLIPTIC FUNCTIØNS SN, CN, DN
ØRTHP      FF     EVALUATE ØRTHØGØNAL PØLYNØMIALS
STIRLING   FP-S   N FACTØRIAL BY STIRLINGS APPRØXIMATIØN
TMFCEV     B      EVALUATE DAMPED ØR UNDAMPED FØURIER SERIES

***LØGIC AND NUMBER THEØRY*
                              **

4SQRS      B      WRITES INTEGERS AS SUM ØF SQUARES ØF FØUR INTEGERS
BASE       FP     CØNVERTS NUMBERS FRØM ØNE BASE TØ ANØTHER
CØNCLUDE   9      DETERMINES LØGICAL CØNCLUSIØNS FRØM PRØPØSITIØNAL LØGIC
GCDN       FS     G.C.D. ØF N INTEGERS

**********************ST--STATISTICS**************************************

***CURVE FITTING AND REGRESSIØN***
CFIT       FP     LEAST SQRS. PØLY. WITH RESTRAINTS
CURFIT     B      FITS SIX DIFFERENT CURVES BY LEAST SQRS
FØRIR      FP     LEAST SQUARES ESTIMATE ØF FINITE FØURIER SERIES MØDEL
FØURIER    B      CØEFF ØF FØURIER SERIES TØ APPRØX A FUNCTIØN
LINEFIT    FS     LEAST SQRS LINE
LINREG     B      LST.SQRS. BY LINEAR, EXPØNENTIAL, ØR PØWER FUNCTIØN
LSPCFP     FP     LEAST SQRS PØLYNØMIAL FIT
LSQMM      FS     GENERALIZED PØLY FIT BY LEAST SQRS ØR MIN-MAX
MREG1      FP     MULTIPLE LINEAR REGRESSIØN
MULFIT     B      MULTIPLE LINEAR FIT WITH TRANSFØRMATIØNS
ØRPØL      FP     LEAST SQRS FIT WITH ØRTHØGØNAL PØLYS
PØLFIT     B      LEAST SQRS PØLYNØMIAL FIT
PØLFT      FP     LEAST SQRS PØLYNØMIAL FIT
SMLRP      FP     MULTIPLE LINEAR REGRESSIØN
STAT20     B      EFFRØYMSØN'S MULTIPLE LINEAR REGRESSIØN ALGØRITHM
STAT21     B      CØMPUTES MULTIPLE LINEAR REGRESSIØNS

***ANALYSIS ØF VARIANCE***
ANØVA      FP     ØNE ØR TWØ WAY ANALYSIS ØF VARIANCE
ANVA1      FP     ØNEWAY ANALYSIS ØF VARIANCE
ANVA3      FP     THREE WAY ANALYSIS ØF VARIANCE
ANVA5      FP     MULTIPLE VARIANCE ANALYSIS
KRUWAL     FP     KRUSKAL-WALLIS 2-WAY VARIANCE (XINGAM)
ØNEWAY     B      ØNEWAY ANALYSIS ØF VARIANCE
STAT13     B      ANALYSIS ØF VARIANCE TABLE, 1-WAY RANDØM DESIGN
STAT14     B      ANALYSIS ØF VARIANCE TABLE FØR RANDØMIZED BLØCK DESIGN
STAT15     B      ANALYSIS ØF VARIANCE TABLE FØR SIMPLE LATIN-SQ DESIGN
STAT16     B      ANALYSIS ØF VARIANCE TABLE, GRAECØ-LATIN SQUARE DESIGN
STAT17     B      ANØVA TABLE ØF BALANCED INCØMPLETE BLØCK DESIGN
STAT18     B      ANALYSIS ØF VARIANCE TABLE, YØUDEN SQUARE DESIGN
STAT33     B      ANALYSIS ØF VARIANCE TABLE, 1-WAY RANDØM DESIGN
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***PRØBABILITY DISTRIBUTIØNS***
ANPF        FF     NØRMAL PRØBABILITY FUNCTIØN (ERRF)
BETA        FF     BETA DISTRIBUTIØN
BINDIS      B      BINØMIAL PRØBABILITIES
EXPLIM      B      EXPØNENTIAL DISTRIBUTIØNS
PØISØN      FF     PØISSØN DISTRIBUTIØN FUNCTIØN
PRØBC       FP     PRØBABLITIES ØF CØMBINATIØNS ØF RANDØM VARIABLES
PRØVAR      B      NØRMAL AND T-DISTRIBUTIØN
TDIST       FF     T-DISTRIBUTIØN (BETA)
XINGAM      FF     INCØMPLETE GAMA FUNCTIØN

***CØNFIDENCE LIMITS***

BAYES       B      DIFFERENCE ØF MEANS IN NØN-EQUAL VARIANCE
BICØNF      B      CØNF. LIMITS FØR PØPULATIØN PRØPØRTIØN (BINØMIAL)
BINØM       FP     BINØMIAL PRØBABILITIES AND CØNFIDENCE BANDS
CØLINR      B      CØNFIDENCE LIMITS ØN LINEAR REGRESSIØNS
CØNBIN      B      CØNF. LIMITS FØR PØPULATIØN PRØPØRTIØN (NØRMAL)
CØNDIF      B      DIFFERENCE ØF MEANS IN EQUAL VARIANCE
CØNLIM      B      CØNF. LIMITS FØR A SAMPLE MEAN
STATØ5      B      CØNFIDENCE INTERVAL FØR MEAN BY SIGN TEST
STATØ6      B      CØNFIDENCE LIMITS,WILCØXØN SIGNED RANK SUM TEST

***HYPØTHESIS TESTING*
                        **

BITEST      B      TEST ØF BINØMIAL PRØPØRTIØNS
CHISQR      FS     CHI-SQUARE CALCULATIØNS
CØRREL      FP     CØNTINGENCY CØEFFICIENT (XINGAM)
CØRRL2      FP     CØRRELATIØN CØEFFICIENT (TDIST,BETA)
KØKØ        FP     KØLMØGØRØV-SMIRNØV TWØ SAMPLE TEST (XINGAM)
SEVPRØ      B      CHI-SQUARE
STATØ1      B      MEAN,STD ØF MEAN, ... , T-RATIØ,2 GRØUPS, PAIRED
STATØ2      B      MEANS, VARIANCES, AND T-RATIØ 2 GRØUPS, UNPAIRED DATA
STATØ4      B      CHI-SQUARE AND PRØBABILITIES, 2X2 TABLES
STATØ8      B      CØMPARES TWØ GRØUPS ØF DATA USING THE MEDIAN TEST
STATØ9      B      CØMPARE 2 DATA GRØUPS,MANN-WHITNEY 2-SAMPLE RANK TEST
STAT11      B      SPEARMAN RANK CØRRELATIØN CØEF. FØR 2 SERIES ØF DATA
STAT12      B      CØMPUTES CØRRELATIØN MATRIX FØR N SERIES ØF DATA
TAU         FP     KENDALL-RANK CØRRELATIØN

***DESCRIPTIVE STATISTICS***
MANDSD      B      FIND MEAN, VARIANCE, STD
STAT        FP     FIND SEVERAL STATISTICS FØR SAMPLE DATA (ANPF,ERRF)
STATAN      B      FIND VARIØUS STATISTICAL MEASURES
TESTUD      B      SAMPLE STATISTICS
UNISTA      B      DESCRIPTIØN ØF UNI-VARIANT DATA

***RANDØM NUMBER GENERATIØN***
FLAT        GRF    UNIFØRM RANDØM NUMBER GENERATØR
FLATSØRC    C      CARDIN SØURCE FILE FØR FLAT
RANDX       FF     RANDØM #'S, UNIFØRM DIST. BETWEEN 0 AND 1
RNDNRM      FF     CALCULATES NØRMAL RANDØM NUM. (FLAT)
UNIFM       GRF    UNIFØRM RANDØM NUMBER GENERATØR
UNIFMSØR    C      CARDIN SØURCE FILE FØR UNIFM
URAN        GRF    UNIFØRM RANDØM NUMBER GENERATØR
URANSØRC    C      CARDIN SØURCE FILE FØR URAN
XNØR1       FF     NØRMAL RANDØM NUMBERS, VARIABLE MEAN, STD (RANDX)
XNØRM       FF     NØRMAL RANDØM NUMBERS, MEAN 0, STD 1. (RANDX)

***MISCELLANEØUS STATISTICS***
FACTAN      FP     FACTØR ANALYSIS
STADES             EXPLANATIØN ØF CØLINR,CURFIT,MULFIT,UNISTA
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**********MS--MANAGEMENT SCIENCE AND ØPTIMIZATIØN*
                                                  ***********

***LINEAR PRØGRAMMING***
ASIGNIT    B      THE ASSIGNMENT PRØBLEM
LINPRØ     B      LINEAR PRØGRAMMING
LNPRØG     FP     LINEAR PRØGRAMMING
SIMPLEX    B      LINEAR PRØGRAMMING BY THE SIMPLEX METHØD
TRANSPØ    B      THE TRANSPØRTATIØN PRØBLEM
UNDEQ      FS     FINDS A SØLUTIØN FØR AN UNDERDETERMINED LINEAR SYSTEM

***INTEGER PRØGRAMMING***
INTØ1      FP     ZIØNTS' MØDIFICATIØN ØF BALAS' ZERØ-ØNE ALGØRITHM
INTLP      FP     GØMØRY'S PURE AND MIXED INTEGER PRØGRAMMING

***NØN-LINEAR ØPTIMIZATIØN***
CSM        FS     ØPTIMIZE A LINEARLY CONSTRAINED CØNVEX FUNCTIØN(UNDEQ)
DAVIDØN    B      DAVIDØN'S UNCØNSTRAINED ØPTIMIZATIØN
GEØSIM     B      HEURISTIC SCHEDULING ØF N JØBS IN A M MACHINE SHØP
GPRØG      FHP    SØLVES GEØMETRIC PRØGRAMMING PRØBLEMS
GPRØG-SØ   C      CARDIN SØURCE FILE FØR GPRØG (UNDEQ;CSM)
JSSIM      B      SCHEDULES N JØBS IN A SHØP WITH M MACHINES
LAYØUT     B      ØPTIMIZES A PLANT LAYØUT ACCØRDING TØ VØLLMANN-RUML MØDE
LØGIC3     FP     UNCØNSTRAINED ØPTIMIZATIØN
MAXØPT     FP     UNCØNSTRAINED ØPTIMIZATION

***NETWØRK ANALYSIS***
CPM        FP     CRITICAL PATH METHØD
CPMLØØP    FP     DETECTS AND LISTS LØØPS IN A CPM NETWØRK
KILTER     FP     'ØUT ØF KILTER' ALGØRITHM (MINIMUM CØST CIRCULATIØN)
MAXFLØW    FP     MAXIMUM FLØW THRU NETWØRK
PERT       B      SIMPLE ANALYSIS ØF A PERT NETWØRK
SHØRTEST   FP     SHØRTEST PATH - MIN SPANNING TREE

***FØRECASTING***
CØEFS      B      DETERMINE SEASØNAL CØEFFICIENTS ØN TWØ CYCLES
CØMBI      B      DETERMINES ECØNØMIC ØRDER QUANITY FØR INVENTØRY ITEMS
ØPTIM      F      ØPTIMUM SERVICE LEVEL FØR ØNE INVENTØRY ITEM
SMØØTH     FS     TRIPLE SMØØTHING ØF A TIME SERIES
TCAST      FHP    TIME SERIES FØRECASTING

***SIMULATIØN***

GASPDATA   E      DATA FILE FØR SAMPLE PRØGRAM GASPSAMP
GASPIIA    FS     'GASP' SIMULATIØN SYSTEM
GASPSAMP   FP     SAMPLE PRØGRAM FØR GASPIIA (GASPIIA;GASPDATA)

**********EN--ENGINEERING**************************************

ACNET      FP     FREQUENCY RESPØNSE ØF A LINEAR CIRCUIT
BEMDES     B      STEEL BEAM SELECTIØN
GCVSIZ     B      GAS CØNTRØL VALVE CØEFF.
LCVSIC     B      LIQUID CØNTRØL VALVE CØEFF.
LFILTR     B      SYNTHESIZES ACTIVE LØW-PASS FILTERS (LFLDAT)
LFLDAT            DATA FØR LFILTR
LFLTIN            INSTRUCTIØNS FØR LFILTR
LPFILT     B      DESIGN LØW PASS FILTERS
NLNET      FP     GENERAL STEADY-STATE CIRCUIT ANALYSIS
ØTTØ       B      ØTTØ CYCLE ØF ENGINE
PAVEIT     B      CALCULATES $ CØST AND TØNS ØF MATERIAL TØ PAVE A RØAD
PVT        FP     FINDS MØLAR VØLUME ØF A GAS GIVEN TEMPERATURE AND PRES.
SCVSIZ     B      STEAM CØNTRØL VALVE CØEFF.
SECAP      B      STEEL SECTIØN CAPACITIES
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**********GP-GEØMETRIC AND PLØTTING**********

CIRCLE     B      DIVIDES A CIRCLE INTØ N EQUAL PARTS
PLØT       FS     PLØTS UP TØ 9 CURVES SIMULTANEØUSLY
PLØTTØ     B      SIMULTANEØUSLY PLØTS 1 TØ 6 FUNCTIØNS
PLØT1      FS     PLØTS UP TØ 9 CURVES SIMULTANEØUSLY
PØLPLØ     FP     PLØTS EQNS IN PØLAR CØØRDINATES
SPHERE     B      SØLVES ANY SPHERICAL TRIANGLE
TRIANG     B      SØLVES FØR ALL PARTS ØF ANY TRIANGLE
TWØPLØ     B      SIMULTANEØUSLY PLØTS 2 FUNCTIØNS
XYPLØT     B      PLØTS SINGLE-VALUED FUNCTIØNS

**********
          *******ED--EDUCATIØN AND TUTØRIAL**********

DRIVES     FHP    DRIVER FØR EXPER. A CØMPUTER ASSISTED INST. LANG.
EXPERN     E      EXPER TUTØRIALS IN EXPER (N=1 TØ 5) (PREPRS,DRIVES)
PREPRS     FHP    PREPRØCESSØR FØR EXPER. A CØMPUTER ASSISTED INST. LANG.

**
  **********DE--DEMØNSTRATIØN**********

AMAZE      B      CØNSTRUCTS MAZES     -  EACH UNIQUE
BLKJAK     B      THE CØMPUTER DEALS BLACKJACK
MØØNER     B      SIMULATES A LUNAR LANDING(MØØNER1,MØØNER2)
MØØNER1           DATA FILE FØR FØR MØØNER
MØØNER2           INSTRUCTIØNS FILE FØR MØØNER
PØPING     B      PØPULATIØN PRØJECTIØNS FØR AN AREA
PRIME      B      PRIME FACTØRIZATIØN ØF A NUMBER
XMAS       B      A HØLIDAY SING-ALØNG, CHRISTMAS CARD AND GREETINGS

**********UM--UTILITY AND MISCELLANEØUS**********

ADATER     FP-S   A CALENDER DATING RØUTINE
ACCESS     GS     GMAP SUBRØUTINE TØ USE T/S ACCESS SYSTEM          (APPLIB
APARAM     GS     GMAP SUBRØUTINE TØ DETERMINE T/S ØR BATCH MØDE    (APPLIB
APPLIB     GL     USERS LIBRARY ØF FØRTRAN CALLABLE GMAP RØUTINES(APPLIB-R
ASCBCD     GS     GMAP SUBRØUTINE TØ CØNVERT ASCII TØ BCD           (APPLIB
BCDASC     GS     GMAP SUBRØUTINE TØ CØNVERT BCD TØ ASCII           (APPLIB
CALLSS     GS     GMAP SUBRØUTINE TØ CALL A T/S SUBSYSTEM           (APPLIB
CATALØG    E      CATALØG ØF SERIES 6000/600 T/S LIBRARY (THIS FILE)
CØNVRT     B      CØNVERTS MEASUREMENTS FRØM ØNE SCALE TØ ANØTHER
DBLSØRT    FS     SØRT TWØ ARRAYS
DCS        FS     FØRTRAN SUBR. TØ TRANSFER CHARACTERS FRØM STRING TØ STRI
DEFIL      GS     GMAP SUBRØUTINE TØ CREATE TEMPØRARY FILES         (APPLIB
DESEQ      FP     STRIPS LINE SEQUENCE NUMBERS FRØM A FILE
GMAP       FP     FØRTRAN--AN INTERFACE TØ GMAP ASSEMBLER  (GMAP-SØR)
KIN        GS     GMAP SUBR.TØ READ LAST LINE FRØM TERM. IN BUFF.   (APPLIB
REFØRM     FP     REFØRMATS A 'NFØRM' FØRTRAN SØURCE FILE TØ 'FØRM'
RLINE      FS     READS LINE, ØPTIØNALLY STRIPS LINE # & CØUNTS ENTRIES
SGLSØRT    FS     SØRT AN ARRAY
TLU1       FS     TABLE SEARCH
TPLSØRT    FS     SØRT THREE ARRAYS
UATØLA     GS     GMAP SUBR. TØ CHANGE CASE ØF ASCII CHAR. STRING   (APPLIB
```

```
**********BF--BUSINESS AND FINANCE**********

ACCRUIT    B      C0MPUTES AND PRINTS ACCRUED INTEREST 0N INSTALLMENT L0AN
ANNUIT     B      ANNUITIES,L0ANS,M0RTGAGES
BALANCE    B      A PR0GRAM T0 REC0NCILE A BANK STATEMENT BALANCE
BLDGC0ST   B      ANALYZE BUILDING C0STS
B0NDATA    B      ANALYSIS 0F A B0ND INVESTMENT P0RTF0LI0
B0NDPR     B      C0MPUTES PRICE AND ACCRUED INTEREST 0F A B0ND
B0NDSW     B      CALCULATES THE EFFECT 0F A B0ND SWITCH
B0NDYD     B      C0MPUTES B0ND YIELDS
CASHFL0W   B      PREDICTS NEXT YEARS CASH FL0W
DEPREC     B      CALCULATES DEPRECIATI0N BY F0UR METH0DS
INSTL0     B      CALCULATES M0NTHLY PAYMENT SCHEDULE 0N INSTALLMENT L0A
INTRSTZ    B      INTEREST RATES REGARDLESS 0F PAYMENT STREAM --REGULATI0N
INVANL     FP     RETURN 0N INVESTMENT ANALYSIS
LESSEE     B      C0MPARES A LEASE WITH PURCHASE 0F EQUIPMENT
LESSIM     B      SIMULATES LESS0R'S CASH FL0W AND RATE 0F RETURN
LESS0R     B      CALCULATES THE LESS0RS CASH FL0W & RATE 0F RETURN
MAKE-BUY   B      T0 MAKE 0R T0 BUY DECISI0NS
MGSIM      FP     SIMULATES C0MPETITIVE INTERACTI0N 0F C0MPANIES
MGSIM-IN          0N LINE INSTRUCTI0NS F0R MGSIM
M0RTCST    B      M0RTGAGE SCHEDULE F0R VARI0US TERMS
M0RTGAGE   FP     CALCULATES A M0RTGAGE REPAYMENT SCHEDULE
N0M-EFF    B      C0MPUTES MULTIPLE EFFECTIVE ANNUAL RATES 0F INTEREST
RETURN     B      C0MPUTES ANNUAL RETURNS F0R A SECURITY FR0M ANNUAL DATA
RISKIT     B      RISK ANALYSIS BASED 0N HERTZ'S SIMULATI0N M0DEL
SALDATA    B      C0MPUTES PR0FITABILITY 0F DEPARTMENTS 0F A FIRM
SAVING     B      SAVINGS PLAN CALCULATI0NS
SIMFUND    B      SIMULATES L0NG-RUN PERF0RMANCE 0F FUNDS(SIMPL0T)
SIMPL0T    B      PL0TTING PR0GRAM F0R SIMFUND HIST0GRAMS
SMLBUS     B      PAYMENT SCHEDULES F0R A SMALL BUSINESS ADMST. L0AN
TRUINT     B      INTEREST RATE CALCULATI0NS
VALSTK     B      CALCULATES INTRINSIC VALUE 0F ST0CK--M0L0D0VSKY METH0D

***END 0F CATAL0G***
```

This FORTRAN program computes the earliest (ES) and latest (LS) permissible start times, earliest (EF) and latest(LF) finish times, total float (TF), and free float (FF) for the activities of a project network model. The program also determines the critical path through the network and, at the user's option, calculates direct cost, percent completion, and calendar dates.

RESTRICTIONS

1. The nodes (events) of the arrow diagram can be numbered randomly with any number from 0 to 4095.
2. Each activity must have a nonnegative duration expressed in whole days.
3. The maximum problem size is limited by:

   $2*$ (highest numbered node) + (# activities) + 2 $\leq$ MX

   and, if calendar dating is desired:

   (project duration) + $2*$ (highest numbered node) + 3 $\leq$ MX,

   where MX is currently set to 3000. MX can be reset by changing the parameter statement near the beginning of the program.

   NOTE: The head of the job arrow (J) does not have to be numbered larger than the tail (I). There can be more than one arrow with the same I and J, and the activities can be input in any order.

DATA FILE FORMAT

The data should be entered in a file before executing the program, either with or without line numbers. Three types of information must be entered in the data file: data file format information, activity data and, if desired, calendar dating information.

The first line in the file contains alphanumeric problem identification. If the first character of this line is numeric, the program assumes the data file was built with line numbers.

The second line gives the format of the activity data and is in the following format:

(line #) $\left\{\begin{matrix}\text{COST}\\\text{NCOST}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{PRCNT}\\\text{NPRCNT}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{DESCR}\\\text{NDESCR}\\\text{LDESCR}\end{matrix}\right\}$ linesize, media

The entries on this line have the following meanings.

COST	Activity cost is included and is to be processed.
NCOST	Activity cost is not included or is included but neither cost nor percent are to be processed.
PRCNT	Activity percent completed is included and is to be processed.
NPRCNT	Activity percent completed is not to be processed.
DESCR	Alphanumeric activity identification is on the same line as the rest of the activity data and is to be processed. The identification must begin with a nonnumeric character.
NDESCR	Alphanumeric activity identification is not to be processed but can still be included on the same line as the rest of the activity data.
LDESCR	Alphanumeric activity identification is on the line following the rest of the activity data and is to be processed. The identification must begin with a nonnumeric character.
linesize	The number of character positions per line on the output device.
media	The media code to use in writing the network report data includes:

media = 3	BCD print line
media = 5	TS ASCII
media = 6	System standard ASCII

Beginning on the third line, the activity data is entered in free format as indicated below and as described in the first two lines of the data file. Note that all numeric values are entered in integer mode only. The items in parentheses below are optional:

(line #) I J duration (cost) (percent) (identification)

or

(line #) I J duration (cost) (percent)

(line #) identification

If calendar dating is desired, the last line should have I = J = duration = cost = percent = 0.

The program tests for errors and issues the following error messages:

1. I-J errors — I or J greater than 4095, negative, or I = J.
2. Problem too big for allocated storage.
3. Multiple start or finish nodes.
4. A loop in the network. In this case, the activity identified is either on the loop or on a sequence of jobs that pass through a node of the loop.

For calendar dating, the first line following the activities is the starting date in the following format. If the starting month number is negative, the calendar dating is ignored.

(line #) month #, day of month, day of week #

Following the starting date, the nonworking days of the week and the holidays are entered for each year the project is expected to cover. This data is entered one item per line in the following order:

(line #) last two digits of year
(line #) a nonworking day of week
etc.
(line #) -1 (end of nonworking days)
(line #) holiday month #, day
etc.
(line #) -1, -1 (end of holidays)
(line #) last two digits of next year
etc.
.
.
.
(line #) last holiday of last year

INSTRUCTIONS

If the data file was named 05 or has already been accessed under the alternate name 05, the program can be executed by typing:

```
RUN LIBRARY/CPM,R=(CORE=23)#05
```

If the data file has a name other than 05, for example, CPMDATA, the program can be executed by typing:

```
RUN LIBRARY/CPM,R=(CORE=23)#CPMDATA "05"
```

If the activity data is to be written to a file rather than to a terminal, type the following command line (depending upon particular core allocated):

```
RUN LIBRARY/CPM,R=(CORE=23)#05;06
```

The activity data will be written to file 06. Error messages and project summaries will still be sent to the terminal.

This program can also be executed in the batch environment by submitting a job similar to the following:

```
$    IDENT
$    OPTION          FORTRAN
```

```
$    FORTY       ASCII, LNO, NFORM, OPTZ
$    LIMITS      , 32K
$    PRMFL       S*, READ, SEQ, LIBRARY/CPM
$    EXECUTE
$    LIMITS      , 13K
$    PRMFL       05, READ, SEQ, userid/datafile
$    ENDJOB
```

SAMPLE PROBLEM

Figure 1 is an arrow diagram for a sample project. The problem is first solved without calendar dating and then with calendar dating.

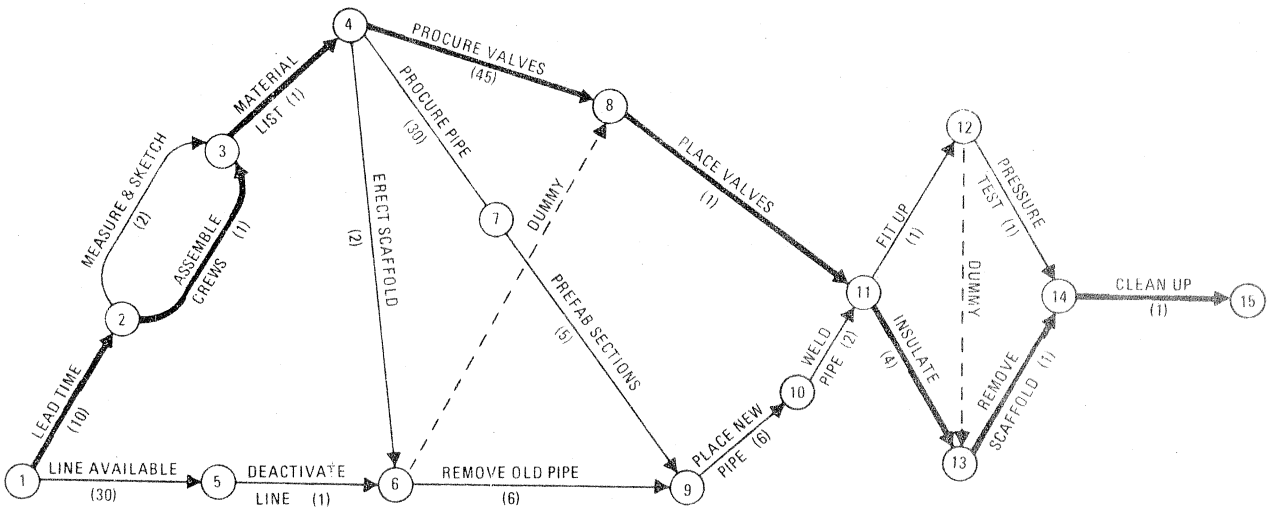


Figure 1. Sample Arrow Diagram for Renewal of Pipeline

SAMPLE SOLUTION 1 — WITHOUT CALENDAR DATING

```
*@LD 05
READY
*LIST

010 TEST CPM PR@GRAM -- NO CALENDER DATING
020 C@ST PRCNT DESCR 118 5
30 1 2 10 0 100
040 1 5 30 0 100 LINE AVAILABLE
050 2 3 2 25 100 MEASURE & SKETCH
060 2 3 1 300 100 ASSEMBLE CREWS
070 3 4 1 10 100 MATERIAL LIST
080 5 6 1 75 50 DEACTIVATE LINE
090 4 6 2 100 45 ERECT SCAFF@LD
100 4 7 30 100 10 PR@CURE PIPE
110 4 8 45 150 15 PR@CURE VALVES
120 6 8 0 0 0 DUMMY
130 7 9 5 220 0 PREFAB SECTIONS
140 9 10 6 120 0 PLACE NEW PIPE
150 10 11 2 150 0 WELD PIPE
160 8 11 1 75 0 PLACE VALVES
170 11 12 1 30 0 FIT UP
180 11 13 4 80 0 INSULATE
190 12 13 0 0 0 DUMMY
200 12 14 1 20 0 PRESURE TEST
210 13 14 1 20 0 REM@VE SCAFF@LD
220 14 15 1 20 0 CLEAN UP

READY

*RUN LIBRARY/CPM,R=(C@RE=23)#05

                                *** C P M ***


10 TEST CPM PR@GRAM WITH CALENDER DATING


END @F DATA AFTER   21 ACTIVITIES (I,J=   14   15)
     I    J   DUR   C@ST    %    ES    EF    LS    LF    TF    FF

*    1    2    10      0  100     0    10     0    10     0     0
     1    5    30      0  100     0    30    27    57    27     0 LINE AVAILABE
*    2    3     2     25  100    10    12    10    12     0     0 MEASURE & SK@
     2    3     1    300  100    10    11    11    12     1     1 ASSEMBLE CRE@
*    3    4     1     10  100    12    13    12    13     0     0 MATERIAL LIST
     5    6     1     75   50    30    31    57    58    27     0 DEACTIVATE L@
     4    6     2    100   45    13    15    56    58    43    16 ERECT SCAFF@D
     4    7    30    100   10    13    43    16    46     3     0 PR@CURE PIPE
*    4    8    45    150   15    13    58    13    58     0     0 PR@CURE VALV@
     6    8     0      0    0    31    31    58    58    27    27 DUMMY
     7    9     5    220    0    43    48    46    51     3     0 PREFAB SECTI@
     9   10     6    120    0    48    54    51    57     3     0 PLACE NEW PI@
    10   11     2    150    0    54    56    57    59     3     3 WELD PIPE
*    8   11     1     75    0    58    59    58    59     0     0 PLACE VALVES
    11   12     1     30    0    59    60    62    63     3     0 FIT UP
*   11   13     4     80    0    59    63    59    63     0     0 INSULATE
    12   13     0      0    0    60    60    63    63     3     3 DUMMY
    12   14     1     20    0    60    61    63    64     3     3 PRESURE TEST
*   13   14     1     20    0    63    64    63    64     0     0 REM@VE SCAFF@
*   14   15     1     20    0    64    65    64    65     0     0 CLEAN UP

T@TAL PR@JECT C@ST =   1495

    65 W@RKING DAYS REQUIRED T@ COMPLETE PR@JECT

 38% @F T@TAL PR@JECT C@MPLETED

 30% @F CRITICAL PATH ACTIVITIES C@MPLETED
```

SAMPLE SOLUTION 2 — WITH CALENDAR DATING

```
*ØLD 05
READY
*LIST

010 TEST CPM PRØGRAM WITH CALENDER DATING
020 CØST PRCNT DESCR 118 5
30 1 2 10 0 100
040 1 5 30 0 100 LINE AVAILABLE
050 2 3 2 25 100 MEASURE & SKETCH
060 2 3 1 300 100 ASSEMBLE CREWS
070 3 4 1 10 100 MATERIAL LIST
080 5 6 1 75 50 DEACTIVATE LINE
090 4 6 2 100 45 ERECT SCAFFØLD
100 4 7 30 100 10 PRØCURE PIPE
110 4 8 45 150 15 PRØCURE VALVES
120 6 8 0 0 0 DUMMY
130 7 9 5 220 0 PREFAB SECTIØNS
140 9 10 6 120 0 PLACE NEW PIPE
150 10 11 2 150 0 WELD PIPE
160 8 11 1 75 0 PLACE VALVES
170 11 12 1 30 0 FIT UP
180 11 13 4 80 0 INSULATE
190 12 13 0 0 0 DUMMY
200 12 14 1 20 0 PRESURE TEST
210 13 14 1 20 0 REMØVE SCAFFØLD
220 14 15 1 20 0 CLEAN UP
230 0 0 0 0 0 END ØF ACTIVITY DATA
240  12 29 2   STARTING MØNTH, DAY, DAY ØF WEEK
250 69         STARTING YEAR, WØRK SCHEDULE FØLLØWS
260 1          IS A NØN-WØRK-DAY ØF WEEK
270 7          DITTØ
280 -1         END ØF NØN-WØRK-DAYS
290 12 25      CHRISTMAS IS A HØLIDAY
300 -1 -1      END ØF HØLIDAYS FØR THIS YEAR
310 70         NEXT YEAR
320 1          IS A NØN-WØRK-DAY
330 7          DITTØ
340 -1         END ØF NØN-WØRK-DAYS
350 1 1        NEW YEARS IS A HØLIDAY
360 2 12       LINCØLN'S BIRTHDAY
370 3 27       GØØD FRIDAY


READY

*RUN LIBRARY/CPM,R=(CØRE=23)#05

                              *** C P M ***


10 TEST CPM PRØGRAM WITH CALENDER DATING

     I     J   DUR   CØST   %     ES        EF        LS        LF       TF   FF

*    1     2    10      0 100 12/29/69  1/13/70 12/29/69  1/13/70     0    0
     1     5    30      0 100 12/29/69  2/10/70  2/ 5/70  3/20/70    27    0
*    2     3     2     25 100  1/13/70  1/15/70  1/13/70  1/15/70     0    0
     2     3     1    300 100  1/13/70  1/14/70  1/14/70  1/15/70     1    1
*    3     4     1     10 100  1/15/70  1/16/70  1/15/70  1/16/70     0    0
     5     6     1     75  50  2/10/70  2/11/70  3/20/70  3/23/70    27    0
     4     6     2    100  45  1/16/70  1/20/70  3/19/70  3/23/70    43   16
     4     7    30    100  10  1/16/70  3/ 2/70  1/21/70  3/ 5/70     3    0
*    4     8    45    150  15  1/16/70  3/23/70  1/16/70  3/23/70     0    0
     6     8     0      0   0  2/11/70  2/11/70  3/23/70  3/23/70    27   27
     7     9     5    220   0  3/ 2/70  3/ 9/70  3/ 5/70  3/12/70     3    0
     9    10     6    120   0  3/ 9/70  3/17/70  3/12/70  3/20/70     3    0
    10    11     2    150   0  3/17/70  3/19/70  3/20/70  3/24/70     3    3
*    8    11     1     75   0  3/23/70  3/24/70  3/23/70  3/24/70     0    0
    11    12     1     30   0  3/24/70  3/25/70  3/30/70  3/31/70     3    0
*   11    13     4     80   0  3/24/70  3/31/70  3/24/70  3/31/70     0    0
    12    13     0      0   0  3/25/70  3/25/70  3/31/70  3/31/70     3    3
    12    14     1     20   0  3/25/70  3/26/70  3/31/70  4/ 1/70     3    3
*   13    14     1     20   0  3/31/70  4/ 1/70  3/31/70  4/ 1/70     0    0
*   14    15     1     20   0  4/ 1/70  4/ 2/70  4/ 1/70  4/ 2/70     0    0

TØTAL PRØJECT CØST =    1495

    65 WØRKING DAYS REQUIRED TØ CØMPLETE PRØJECT

PRØJECT START DATE 12/29/69

PRØJECT CØMPLETIØN DATE  4/ 2/70

 38% ØF TØTAL PRØJECT CØMPLETED

 30% ØF CRITICAL PATH ACTIVITIES CØMPLETED
```

This FORTRAN program identifies multiple loops in a CPM-type network. It also isolates other nonlooping elements, such as parallel legs (alternate paths in a loop) and interconnecting strings.

METHOD

This program uses the algorithm described by J. A. Chance.[1]

INSTRUCTIONS

Enter the network description in a data file according to the following rules:

1. The first line contains any alphanumeric problem identification. The routine prints this line on the output report. It also determines whether the file contains preceding line numbers based on the first character of this line (i.e., if the first character of the first line of the data file is numeric, it is assumed the entire file was built with line numbers).

2. The second line informs the program if an alphanumeric activity description has been entered on the line following each activity description. If this line contains an 'L' in any position, it is assumed the data file has been built using two lines for each activity. If it does not contain an 'L', each activity description is contained on only one line.

3. The following lines contain the activity descriptions in the order
   (line #) from node, to node (description)
   or, if the second line contains an 'L',
   (line #) from node, to node (description)
   (line #) description

4. Optionally, the end of data can be flagged by an activity for which from node = to node = 0

NOTE: The data file format for the program CPM is compatible with the data file requirements for this program.

The routine may fail to detect all of the loops in a network by incorrectly classifying some as parallel legs. A second pass is made through the network to attempt to identify any loops that might have been missed on the first pass. However, some parallel legs and interconnecting strings may then be lost.

[1] Chance, J. A., "Multiple Loop Detection in Network Models," General Electric Technical Information Series, Publication No. R64CD1, 1964.

RESTRICTIONS

The size of network that can be analyzed varies, depending on the complexity and the size of the loops. Most problems can be solved if:

(MAX. NODE #) + (MAX. # OF ACTIVITIES) *3 < MAXTAB

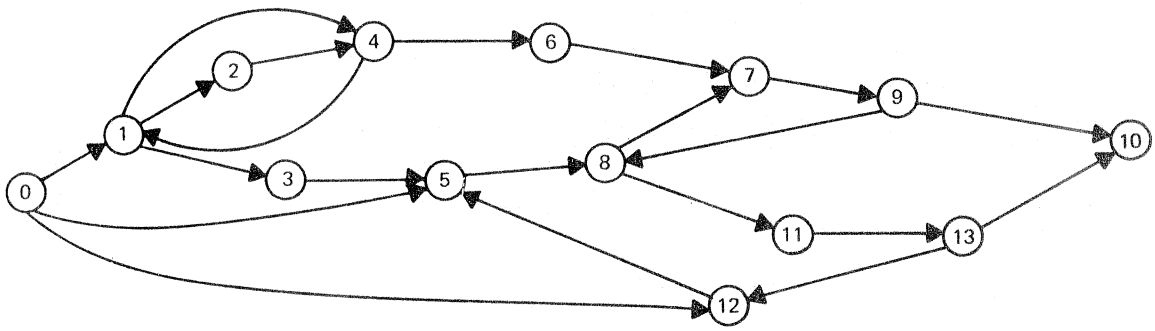
where MAXTAB is set in a parameter statement at line 40 of the program. Currently MAXTAB is set to 1000. If the program requires a larger setting of MAXTAB, an error message will be printed.

Also the node numbers must satisfy

0 ≤ node # < 16384

SAMPLE PROBLEM

Isolate the loops in the following network.



SAMPLE SOLUTION

```
*NEW
READY
*010 TEST DATA FØR CPML00P
*020 NC0ST NPRCNT NDESCR 72 5
*030 0 1
*040 0 5
*050 0 12
*060 1 2
*070 1 3
*080 1 4
*090 2 4
*100 3 5
*110 4 1
*120 4 6
*130 5 8
*140 6 7
*150 7 9
*160 8 7
```

```
*170 8 11
*180 9 8
*190 9 10
*200 11 13
*210 12 5

*220 13 10
*230 13 12
*SAVE L00PDATA
DATA SAVED--L00PDATA

*LIB CPML00P
READY
*RUN
ENTER NAME 0F DATA FILE
=L00PDATA
010 TEST DATA F0R CPML00P


SIMPLE L00P(S)
   7    9          8    7          9    8

-----
   1    4          4    1

-----
   5    8          8   11         11   13        12    5        13   12
```

The file GASPIIA contains a set of FORTRAN subroutines that provide the programmer with a FORTRAN-based simulation language that simulates event-oriented systems. GASPSAMP and GASPDATA are sample problem files.

METHOD

GASPIIA provides routines for event control, statistical collection and computation, report generation, and random number generation. The user must supply the main program, the event routines, and an optional output routine.

NOTE: GASPIIA calls a uniform random number generator in the form:

Y = UNIFM1(X). The library programs FLAT, URAN, or UNIFM can be used.

INSTRUCTIONS

Log onto time sharing under the FORTRAN subsystem, and write a main program and subprograms as needed for the system to be simulated. Then give the command:

RUN*; GASPIIA; FLAT

The program will type:

NAME OF INPUT FILE

Respond with the name of a previously prepared input file.

Input performed by the GASPIIA subroutines will be from this file. If blanks are entered for a file name, the file is the terminal device. The input file is in free-field format except for the first line, which is formatted as described in SIMULATION WITH GASPII (see References). The input file should not have line numbers. The GASP storage map may be listed.

REFERENCES

Pritsker, Alan A., Kiviat, Phillip J., Simulation with GASPII, Englewood Cliffs, New Jersey, Prentice Hall, 1969.

SAMPLE PROBLEM

Sample problem 5 from SIMULATION WITH GASPII has been programmed. The user-supplied coding is stored in the file GASPSAMP. Problem data is stored in the file GASPDATA.

SAMPLE SOLUTION

The execution of GASPIIA is demonstrated by running the sample program with GASPSAMP and GASPDATA. The GASPDATA file is also listed.

```
*LIST GASPDATA

PRITSKER A      504151968    1
 3 2 2 4 20 1 4 22 4
 20 20
 1 2 3 2
 1 1 1 1
 .4 0.0 10.0 1.
 .25 0.0 10.0 1.
 .5 0.0 10.0 1.
 0 1 0 0 0.0 400. 567
 -1 0
 1 1
 0.1 0.0 0.1 0.0
 1 2
 1.0 0.0 0.0 0.0
 1 3
 1.0 0.0 0.0 0.0
 2 0
  0.0 0 0 0
 2 0
  0.0 0 0 0
 2 0
  0 0 0 0
 1 4
 300. 0 0 0
 0 0

READY

*ØLD GASPSAMP
READY
*RUN *;GASPIIA;FLAT
NAME ØF INPUT FILES?
= GASPDATA


 SIMULATIØN PRØJECT NØ.    5  BY  PRITSKER A

 DATE  4/ 15/ 1968              RUN NUMBER     1


  PARAMETER NØ.      1        0.4000        0.          10.0000        1.0000
  PARAMETER NØ.      2        0.2500        0.          10.0000        1.0000
  PARAMETER NØ.      3        0.5000        0.          10.0000        1.0000
DØ YØU WANT TØ SEE A GASP JØB STØRAGE DUMP?
0=NØ, 1=YES
=0
   **INTERMEDIATE RESULTS**
```

```
**GASP SUMMARY REPØRT**

SIMULATIØN PRØJECT NØ.   5  BY  PRITSKER A

DATE  4/ 15/ 1968            RUN NUMBER     1


  PARAMETER NØ.     1       0.4000        0.          10.0000        1.0000
  PARAMETER NØ.     2       0.2500        0.          10.0000        1.0000
  PARAMETER NØ.     3       0.5000        0.          10.0000        1.0000


**
  GENERATED DATA**
CØDE     MEAN        S.DEV.       MIN.         MAX.       ØBS.

  1      3.2337       1.5581      0.2531       7.8550      532
  2      0.5693       0.5704      0.0035       3.4906      532

**TIME GENERATED DATA**
CØDE     MEAN        STD.DEV.      MIN.         MAX.    TØTAL TIME

  1      5.6803       2.0974      0.           8.0000    302.8572
  2      0.4330       0.4955      0.           1.0000    302.8572
  3      0.9108       0.2850      0.           1.0000    302.8572
  4     47.0627      49.9136      0.         100.0000    302.8572

**GENERATED FREQUENCY DISTRIBUTIØNS**
CØDE                        HISTØGRAMS

  1        10  18  32  51  74  80  73  53  32  32  20
           22  14  12   7   2   0   0   0   0   0   0

  2         0 140 111  72  48  41  35  18  21  13   7
            6   5   6   3   2   0   0   1   1   2   0


 FILE PRINTØUT, FILE NØ.  1

AVERAGE NUMBER IN FILE WAS,     2.3528
STD. DEV                        0.5758
MAXIMUM                            4

 FILE CØNTENTS

NSET

THE FILE IS EMPTY


 FILE PRINTØUT, FILE NØ.  2

AVERAGE NUMBER IN FILE WAS,     2.2755
STD. DEV                        1.4822
MAXIMUM                            4
```

```
 FILE CONTENTS

NSET

THE FILE IS EMPTY


 FILE PRINTOUT, FILE NO.  3

AVERAGE NUMBER IN FILE WAS,     1.5625
STD. DEV                        0.7314
MAXIMUM                            2

 FILE CONTENTS

NSET

THE FILE IS EMPTY


 FILE PRINTOUT, FILE NO.  4

AVERAGE NUMBER IN FILE WAS,     0.4706
STD. DEV                        0.4991
MAXIMUM                            1

 FILE CONTENTS

NSET

THE FILE IS EMPTY


MEAN TIME BETWEEN ARRIVALS =0.40
MEAN SERVICE TIME FOR STATION 1 =0.25
MEAN SERVICE TIME FOR STATION 2 =0.50
PERCENT OF ITEMS SUBCONTRACTED = 27.21
NUMBER OF ITEMS SUBCONTRACTED = 197.
TOTAL ITEMS =  724.
```

This FORTRAN program solves the zero-one integer programming problem using a modification of Balas' method of implicit enumeration.

INSTRUCTIONS

To use this program, formulate the problem to be solved according to the following standard:

Minimize

$$\sum_{i=1}^{n} a_{oi} x_i$$

subject to

$$a_{jo} \geq \sum_{i=1}^{n} a_{ji} x_i \qquad j=1, \ldots, m$$

and $x_i = 0$ or 1, $\quad i = 1, \ldots, n$

Hence, n is the number of variables and m is the number of constraints. If m is greater than 11 or n is greater than 28, the dimensions in the program must be increased.

All of the coefficients, a_{ij}, should be integer. Establish a data file with line numbers in the following format:

line #, m, n
line #, 0, a_{o1}, ..., a_{on}
line #, a_{10}, a_{11}, ..., a_{17}
.
.
.
line #, a_{mo}, a_{m1}, ..., a_{mn}

Note that a_{i0} for i = 1 to m are the right-hand side constants. The first entry after the line number on the second line is ignored by this program. It is included to maintain consistency with the data file format used by the INTLP program.

The algorithm asks for a maximum number of iterations to be performed. If the optimum is not found and confirmed within the limit given, data is written on a temporary file 20. The user can then give a new limit on the number of iterations or can stop the

program by giving 0 as the new limit. If the file 20 is saved, the user can continue the problem at a later time, at the point where he left off.

On execution, the program asks if the problem is a new or a restart using data on the file START. It also requests the name of the original data file. If the problem is a new one, the user can specify some variables to be set to one. The algorithm will never consider the cases with those variables set to 0 (see Note 2). If no variables are to be set to 1, enter 0 for the first index.

The program prints out the first feasible answer found and all subsequent feasible answers whose objective value is better than the last feasible answer.

NOTES:
1. Although the optimum answer is usually easily found, it then requires many iterations to verify that it is optimum.
2. The option of setting variables to one may reduce the number of iterations needed to find the optimum; however, this optimum may not be the optimum to the original problem.

REFERENCES

Zionts, Stanley, Implicit Enumeration Using Bonds on Variables: A Generalization of Balas' Additive Alogrithm for Solving Linear Programs With Zero-One Variables, presented at the Operational Research Society of India Annual Meeting, Calcutta, India, November 1968.

SAMPLE PROBLEM

Solve the problem, with four constraints and 20 variables, which has as the coefficient vector of the objective function to be minimized

(3, 2, 5, 8, 6, 9, 11, 4, 5, 6, 11, 2, 8, 5, 8, 7, 3, 9, 2, 4)

The coefficient matrix of the constraints:

$$\begin{bmatrix} -6 & 5 & -8 & -3 & 0 & -1 & -3 & -8 & -9 & 3 & -8 & 6 & -3 & -8 & -6 & 7 & 6 & -2 & 3 & -7 \\ -1 & 3 & 3 & 4 & 1 & 0 & 4 & -1 & -6 & 0 & 8 & 0 & 1 & -5 & -4 & -1 & -9 & -7 & 2 & 2 \\ 3 & 6 & 1 & -3 & -5 & 6 & -9 & 6 & 3 & -9 & -6 & -3 & -6 & -6 & 6 & 2 & -7 & -6 & 0 & -7 \\ 1 & 4 & 2 & -1 & 1 & 1 & 1 & -7 & -8 & -9 & -8 & -7 & -9 & 1 & 1 & 0 & 1 & 2 & 1 & -3 \end{bmatrix}$$

and the right hand sides of the constraints

(-25, -13, -15, -13)

SAMPLE SOLUTION

The data was stored in the file IN01IN. The program ran with a maximum of 100 iterations, and then stopped. The restart capability was illustrated by running the program again with a maximum of 500 iterations. No new feasible solutions were found, so the maximum was increased to 900 iterations. Notice that when signing off, the user is given the option of saving the temporary file 20.

```
*RUN

INTO1

0=NEW PROBLEM, 1=RESTART ON OLD PROBLEM
= 0
NAME OF THE DATA FILE
= IN01IN
MAX # OF ITER BEFORE DECISION POINT
= 100
INDICES OF VARIABLES TO BE SET    1, ONE AT A TIME
(0 STOPS SCAN)
= 0

***FEASIBLE POINT***
ALL VARIABLES ARE 0 EXCEPT:
X(  9)=1
X( 13)=1
X( 14)=1
X( 18)=1
X( 20)=1
Z=          31 ITER=           5

***FEASIBLE POINT***
ALL VARIABLES ARE 0 EXCEPT:
X(  1)=1
X(  9)=1
X( 13)=1
X( 14)=1
X( 17)=1
X( 20)=1
Z=          28 ITER=          13

***FEASIBLE POINT***
ALL VARIABLES ARE 0 EXCEPT:
X(  5)=1
X(  8)=1
X(  9)=1
X( 14)=1
X( 17)=1
X( 20)=1
Z=          27 ITER=          83

AT ITER         100 RESTART FILE BUILT
WHAT IS NEW ITMAX (0=STOP)
= 0

PROGRAM STOP AT 700
*RUN

INTO1

0=NEW PROBLEM, 1=RESTART ON OLD PROBLEM
= 1
NAME OF THE DATA FILE
= IN01IN
MAX # OF ITER BEFORE DECISION POINT
  500
```

```
 BEST SØLUTIØN FØUND PREVIØUSLY

 ALL VARIABLES ARE 0 EXCEPT:
 X(  5)=1
 X(  8)=1
 X(  9)=1
 X( 14)=1
 X( 17)=1
 X( 20)=1
 Z=          27 ITER=          100

 AT ITER          500 RESTART FILE BUILT
 WHAT IS NEW ITMAX (0=STØP)
 = 900


 ***ØPTIMUM***

 ALL VARIABLES ARE 0 EXCEPT:
 X(  5)=1
 X(  8)=1
 X(  9)=1
 X( 14)=1
 X( 17)=1
 X( 20)=1
 Z=          27 ITER=          890

*BYE
   1 TEMPØRARY FILES CREATED.

 20       ?
```

The data was saved in the file IN01IN and is listed below:

```
*LIST IN01IN

010  4,20
020  0,     3,2,5,8,6,9,11,4,5,6,11,2,8,5,8,7,3,9,2,4
030 -25,    -6,5,-8,-3,0,-1,-3,-8,-9,3,-8,6,-3,-8,-6,7,6,-2,3,-7
040 -13,    -1,3,3,4,1,0,4,-1,-6,0,8,0,1,-5,-4,-1,-9,-7,2,2
050 -15,    3,6,1,-3,-5,6,-9,6,3,-9,-6,-3,-6,-6,6,2,-7,-6,0,-7
060 -13,    1,4,2,-1,1,1,1,-7,-8,-9,-8,-7,-9,1,1,0,1,2,1,-3

READY

*
```

This FORTRAN program uses Gomory's method to solve both the pure-integer and mixed-integer programming problems. The user can actively interface with the program by changing the method of picking the new constraints and by being able to add certain information to the problem in an effort to speed up convergence.

INSTRUCTIONS

To use this program, formulate the problem to be solved according to the following standard:

Minimize

$$a_{oo} + \sum_{i=1}^{n} a_{oi} x_i$$

subject to

$$a_{jo} \geq \sum_{i=1}^{n} a_{ji} x_i \quad , \quad j=1, \ldots, m$$

Hence n is the number of variables and m is the number of constraints. All of the coefficients a_{ij} should be integer.

Establish a data file with line numbers in the following format:

line # , m, n
line # , a_{oo}, a_{o1}, ... , a_{on}
line # , a_{mo}, a_{m1}, ... , a_{mn}

On executing the program, the user is asked to supply the method to be used; the changes, if any, to be made to the data; and when to print out the iteration log. Every five times the log is printed out, the user can decide if he wants to stop, or continue the solution, or restart the problem from the beginning. If he chooses to continue, he can change the printing of the iteration log and the method to be used. The following items should be supplied when requested by the program.

- The name of the data file
- LSTART — The iteration when the log should be first printed out
- LOFTEN — How often should the log be printed

- LMUCH — How much of the log does the user wish to see

  LMUCH = 1) Print the entire log
  2) Do not print the values of the variables

- METHOD — The method to be used in choosing the new constraints

  Methods 1 through 5 are for the pure integer case. Method 6 is the mixed case.

  METHOD = 1 Generate the new constraint from the row with the greatest RHS fractional part.

  2 Generate the new constraint from the row with the smallest average fractional part of the coefficients.

  3 Generate the new constraint from the row with the smallest ratio of the RHS fractional part and the average fractional part of the coefficients

  4 Use the Euclidian algorithm to generate the new constraint from the linear combination of two rows that are likely to produce a deep cut in the axis along which the objective function decreases most slowly.

  5 Use the rows cyclicly to generate the new constraints

  6 This method is for the mixed case. Its selection causes the program to ask for the number of variables constrained to integer values and their indices. Care should be used with this method to avoid changing the problem by specifying different variables to be integer at the various decision points.

- CHANGES — The number of changes to be made to the data before starting. If there are changes to be made, the user will be asked

  VARIABLE #, VALUE

  for each change. The permissible responses are:

  (a) A variable number (1 through N) and the value at which it is fixed. This option eliminates the variable and its column from any manipulation by the program.

  (b) 0, X. This option appends the constraint: objective value $\geq$ X to the problem.

  (c) -1, X. This option appends the constraint: objective value $\leq$ X to the problem.

- NEXT — After printing the iteration log five times, the user is given the choice of

  1) Stop
  NEXT = 2) Continue
  3) Begin the problem again

NOTE: If the objective function has not changed for several iterations, the program may be looping indefinitely through the same points. If this occurs, another method should be tried. Also, another method could be tried profitably whenever the change in the objective function becomes small.

RESTRICTIONS

The program currently cannot handle more than 14 variables and approximately 16 constraints. Also, Gomory's method is known to converge slowly, especially for large problems. However, by wisely using the interface capabilities of this program, many problems can be solved with reasonable effort.

REFERENCES

Gomory, R.E., "An Algorithm for Integer Solutions to Linear Programs," in Recent Advances in Optimization Theory, Ed: Graves & Wolfe, McGraw-Hill, 1963.

Trauth & Woosley, Mesa, An Heuristic Integer Programming Technique, Sandia Laboratories, Albuquerque, New Mexico.

SAMPLE PROBLEM

Minimize $-x_3 -x_4 -x_5$

subject to:

$$180 \geq 20 x_1 + 30 x_2 + x_3 + 2 x_4 + 2 x_5$$

$$150 \geq 30 x_1 + 20 x_2 + 2 x_3 + x_4 + 2 x_5$$

$$0 \geq -60 x_1 + x_3$$

$$0 \geq -75 x_2 + x_4$$

$$1 \geq x_1$$

$$1 \geq x_2$$

SAMPLE SOLUTION

The data was saved in the file INTIN and is listed below:

```
*LIST INTIN

010 6 5
020 0 0 0 -1 -1 -1
030 180 20 30 1 2 2
040 150 30 20 2 1 2
050 0 -60 0 1 0 0
060 0 0 -75 0 1 0
070 1 1 0 0 0 0
080 1 0 1 0 0 0

READY
```

In the following run, method 3 is applied to the original problem, and prints the entire log every iteration starting from iteration 40.

```
INTLP

1=PRINT INSTRUCTIØNS, 0=DØNT
=0
DATA FILE NAME
=INTIN
LSTART,LØFTEN,LMUCH,METHØD,CHANGES
=40 1 1 3 0

ITERATIØN  40 ØBJ= -8.64583330E 01 DETERM.=  1.44E 03
X( 2)=  5.41666664E-01
X( 1)=  2.29166666E-01
X( 3)=  1.37500000E 01
X( 4)=  4.06250000E 01
X( 5)=  3.20833335E 01

ITERATIØN  41 ØBJ= -8.58305540E 01 DETERM.=  3.00E 03
X( 2)=  6.63108736E-01
X( 1)=  4.93662443E-01
X( 3)=  2.96197464E 01
X( 4)=  4.97331553E 01
X( 5)=  6.47765177E 00

ITERATIØN  42 ØBJ= -8.50000000E 01 DETERM.=  5.00E 01
X( 2)=  1.00000000E 00
X( 1)=  5.00000000E-01
X( 4)=  5.50000000E 01
X( 3)=  3.00000000E 01

ITERATIØN  43 ØBJ= -8.50000000E 01 DETERM.=  1.10E 02
X( 2)=  8.18181820E-01
X( 1)=  3.63636363E-01
X( 4)=  6.13636365E 01
X( 5)=  1.81818181E 00
X( 3)=  2.18181818E 01

ITERATIØN  44 ØBJ= -8.46491232E 01 DETERM.=  5.70E 01
X( 2)=  3.50877192E-01
X( 4)=  2.63157895E 01
X( 5)=  5.83333335E 01
X( 3)=  0.
```

Examining the results, it appears that x_2 might end up to be 1, and that the optimal objective value might be -85. The problem is restarted with x_2 constrained to be 1, and the objective function constrained to be greater than or equal to -85. Again, method 3 is used and the only heading of the log is to be printed every 20 iterations.

```
NEXT
=3
LSTART,LØFTEN,LMUCH,METHØD,CHANGES
=20 20 2 3 2
VARIABLE #,VALUE
=0 -85
VARIABLE #,VALUE
=2 1

ITERATIØN  20 ØBJ= -7.98113203E 01 DETERM.=  5.30E 01

ØPTIMUM


ITERATIØN  28 ØBJ= -7.60000000E 01 DETERM.=  1.00E 00
X( 4)=        54
X( 1)=         1
X( 3)=        22
```

We discover a feasible integer solution (1, 1, 22, 54, 0) with an objective value of -76. However, because of the constraint imposed on x_2, it might not be optimal. We learn that any solution must have an objective value between -76 and -85. The problem is restarted using method 3 and including these two constraints on the objective value. Only the heading of the log is printed every 15 iterations.

```
NEXT
=3
LSTART,LØFTEN,LMUCH,METHØD,CHANGES
=20 15 2 3 2
VARIABLE #,VALUE
=0 -85
VARIABLE #,VALUE
=-1 -76

ITERATIØN  20 ØBJ= -8.49455557E 01 DETERM.=  3.95E 03

ITERATIØN  35 ØBJ= -8.49164028E 01 DETERM.=  3.47E 03

ITERATIØN  50 ØBJ= -8.27192984E 01 DETERM.=  5.70E 01

ITERATIØN  65 ØBJ= -7.80000000E 01 DETERM.=  1.00E 02

ITERATIØN  80 ØBJ= -7.70000000E 01 DETERM.=  9.00E 00
```

Good progress is made for 40 iterations, but then little change occurs. The iterations continue using method 5. Only the heading of the log is printed every 15 iterations.

```
NEXT
=2
LØFTEN,LMUCH,METHØD
=15 2 5

ITERATIØN   95 ØBJ= -7.70000000E 01 DETERM.=   1.70E 01

ITERATIØN  110 ØBJ= -7.70000000E 01 DETERM.=   1.90E 01

ITERATIØN  125 ØBJ= -7.70000000E 01 DETERM.=   5.80E 01

ØPTIMUM


ITERATIØN  138 ØBJ= -7.60000000E 01 DETERM.=   1.00E 00
X( 2)=           1
X( 4)=          54
X( 3)=          22
X( 1)=           1

NEXT
=1
*
```

Verification proves that the optimal solution is, in fact, the feasible solution found earlier.

This BASIC program aids in computing the cost improvement made possible through the more efficient layout of a plant, office, warehouse, store, etc.

METHOD

The Vollman-Ruml layout program is based on matrices established by inputting data defining:

- Plant configuration by department (logical divisions).
- Weighted figures for flow exchanges among departments (face-to-face contacts of personnel, order picking labor, material handling systems, including size and nature of items handled, distance traveled, etc.).
- Cost weightings for each department based on above measures.
- Starting layouts.

The program assumes the layout area can be described as rectangular. Also, "dummy", nonmovable departments can be utilized to make the area rectangular where required. More than one starting solution can be specified. A department can be designated as fixed (not movable). Such a fixed department is a washroom area with pipes and plumbing. Larger problems can be solved by increasing the dimension (DIM) statements from their current size of 40 departments.

SAMPLE PROBLEM

For detailed instructions, list the program:

```
*LIST 1-250
```

For sample data as described above, type:

```
*LIST 5000
```

SAMPLE RUN SOLUTION

```
SYSTEM ?BASIC
ØLD ØR NEW-ØLD LAYØUT
READY
*RUN

LAYØUT WILL HANDLE THREE LAYØUT HEURISTICS:
CRAFT (=1), ANY IMPRØVEMENT (=2), AND RANKED PRØDUCT (=3).
```

LAYOUT-2

```
WHICH HEURISTIC 1, 2, ØR 3. ?2

STARTING SØLUTIØN     1
----------------------

INITIAL LAYØUT:
     1      2      3
     4      5      6
THE AVERAGE CØST ØF THE CURRENT LAYØUT IS 6383.75


FINAL LAYØUT
     3      4      2
     5      1      6
THE AVERAGE CØST ØF THE CURRENT LAYØUT IS 4881.25

STARTING SØLUTIØN     2
----------------------

INITIAL LAYØUT:
     3      2      1
     4      5      6
THE AVERAGE CØST ØF THE CURRENT LAYØUT IS 6053.75


FINAL LAYØUT
     3      2      6
     4      1      5
THE AVERAGE CØST ØF THE CURRENT LAYØUT IS 5355


READY
*
```

This FORTRAN program computes the optimum solutions for linear programming problems. Specifically, a linear objective function is maximized (or minimized), subject to a set of linear constraints. Letting X_j refer to the structural variables, S_i to slack variables, and C_j and D_i to the objective function coefficients of the structural and slack variables, the objective function is expressed as:

$$Z = \sum_{J=1}^{n} C_j X_j + \sum_{i=1}^{m} D_i S_i$$

where

- n is the number of structural variables
- m is the number of constraints

Each constraint is of the form:

$$\sum_{j=1}^{n} A_{ij} X_j \leq (\text{or} = \text{or} \geq) B_i$$

where

A_{ij} refers to the structural variable coefficients, and B_i refers to the requirements columns or right-hand side values.

The results of the LP solution consist of an optional iteration log, the basic variable results, and the nonbasic variable results. The structural variables are identified by the number 1 through N. The slack variables associated with each constraint are identified by the numbers 101 through 100+M. Variable identifications 999 and 200+(M+1) are added by the program to handle the "greater than" constraints and do not normally appear in the basic and nonbasic variable results.

The iteration log, which is selected at run time, consists of the iteration count, the identifications of the variables entering and leaving the basis, and the current value of the objective function.

The basic variable results consist of the variable identification, the objective function coefficient, and the answer (value of the variable) for each variable in the final solution.

The nonbasic variable results consist of the variable identification, the objective function coefficient, and the answer (reduced cost or shadow price) for each variable not in the final solution.

An unfeasible condition is indicated by a slack variable associated with an "equal to" constraint and/or the slack variable identified as 200+(M+1) appearing in the basic variable results at other than a zero value. This means that the problem contains two or more constraints that cannot be simultaneously satisfied.

The appearance of a negative identification for a structural variable in the nonbasic results indicates that this variable is unbounded. None of the problem constraints restrict this variable from entering the solution at an infinite value.

INSTRUCTIONS

At execution, the program asks for the data file name. It is assumed this file has been built without line numbers. The first line of data is used for problem identification. The second line contains m (the number of constraints), n (the number of structural variables) and either MAX or MIN indicating whether the problem is a maximization or minimization problem. The next line is the objective function coefficients, C_j. The data for each constraint follows in the following order:

$$A_{ij} \; A_{i2} \cdots A_{in} < B_i \; D_i$$

where " < " can be replaced by " > " or "=" to indicate the sense of the constraint.

The data for additional problems may also be included sequentially in the same file.

RESTRICTIONS

$$m \leq 30$$
$$n \leq 50$$

where

- m is the number of constraints
- n is the number of structural variables

SAMPLE PROBLEM

Maximize the function:

$$Z = -X - Y - Z + W$$

subject to the constraints:

$$\begin{aligned} -X - 1Y + 4Z - 1W &\geq 5 \\ 2Y - Z - W &\geq 4 \\ X - 3Y + 4Z - 4W &\leq 5 \\ X - 2Y &\leq 3 \end{aligned}$$

SAMPLE SOLUTION

The data for this problem was stored in the file LPDATA.

```
*LIST LPDATA

TEST PRØBLEM FØR LP
 4   4   MAX
-1  -1  -1   1
-1  -1   4  -1   >   5   0
 0   2  -1  -1   >   4   0
 1  -3   4  -4   <   5   0
 1  -2   0   0   <   3   0

READY

*RUN

DATA FILE NAME
= LPDATA
TEST PRØBLEM FØR LP
    4 RØWS X  4CØLS
1=PRINT ITERATIØN LØG, 2=SUPPRESS
= 2
ØBJ. FUNCT.     =    -5.00000E+00

  BAS VAR     ØBJ. CØEFF.          RESULT
       2     -1.00000E+00     3.00000E+00
       3     -1.00000E+00     2.00000E+00
     103<     0.               6.00000E+00
     104<     0.               9.00000E+00
N. BAS VAR     ØBJ. CØEFF.          RESULT
       1     -1.00000E+00     1.42857E+00
       4      1.00000E+00     1.42857E-01
     101>     0.               4.28571E-01
     102>     0.               7.14286E-01


*
```

This BASIC program solves small linear programming problems by a simple version of the SIMPLEX method. For similar programs, see LINPRO and LNPROG.

INSTRUCTIONS

For detailed instructions, list the program:

```
*LIST 1000-1710
```

Before using the program, arrange all constraints (linear restrictions on the problem variables) as follows:

1. The "less than or equal" inequalities
2. The strict equalities
3. The "greater than or equal" inequalities

To use the program, starting on line 10000, enter the data in the following order:

1. Coefficients for each of the problem variables (activities). Include zeros for variables not appearing in each restriction, starting with the first restriction, and proceeding in order until all coefficients of all restrictions have been entered in data statements.
2. Elements of the "B" vector (constants comprising the right side of all restrictions) in the same order as the restrictions.
3. The coefficients of the (linear) objective function, in the same order as the restrictions, including zeroes if needed.

Then type RUN.

REFERENCES

Reinfeld and Vogel, Mathematical Programming, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1958.

SAMPLE PROBLEM

Maximize the function: $Z = 4X_1 + 4X_2 + 3X_3$, while satisfying the following constraints:

$$-1X_1 + 2X_2 + 3X_3 \leq 15$$
$$0X_1 - 1X_2 + 1X_3 \leq 4$$
$$2X_1 + 1X_2 - 1X_3 \leq 6$$
$$1X_1 - 1X_2 + 2X_3 \leq 10$$
$$1X_1 + 0X_2 + 0X_3 \leq 8$$
$$0X_1 + 1X_2 + 0X_3 \leq 4$$
$$0X_1 + 0X_2 + 1X_3 \leq 4$$
$$0X_1 + 0X_2 + 1X_3 \geq 3$$

Beginning on line 10000, enter the above constraints in the following order:

```
10000 DATA -1,2,3,0,-1,1,2,1,-1,1,-1,2
10001 DATA  1,0,0,0,1,0,0,0,1,0,0,1
10002 DATA  15,4,6,10,8,4,4,3
10003 DATA  4,4,3
```

As the program runs, MAX is typed for the function, and the value 3 is typed for the number of activities (variables). When the number of constraints is called for, 7,0,1 is typed: 7 is the number of <= restrictions, zero is the number of = restrictions, and one is the number of >= restrictions.

NOTE: The problem solution is:

Variable (activity) $X_1 = 3.4$

Variable (activity) $X_2 = 3.2$

Variable (activity) $X_3 = 4.0$

SAMPLE SOLUTION

```
P
SYSTEM ?BASIC
ØLD ØR NEW-ØLD SIMPLEX
READY
*RUN


LIST THIS PRØGRAM-1000-1710 FØR INSTRUCTIØNS****

READY
*10000 DATA -1,2,3,0,-1,1,2,1,-1,1,-1,2
*10001 DATA 1,0,0,0,1,0,0,0,1,0,0,1
*10002 DATA 15,4,6,10,8,4,4,3
*10003 DATA 4,4,3
*RUN


IS THIS A  MAX  ØR A   MIN  PRØBLEM ?MAX
HØW MANY ACTIVITIES DØES YØUR PRØBLEM HAVE ?3
HØW MANY CØNSTRAINTS IN YØUR PRØBLEM (<=,=,>=) ?7,0,1
DØ YØU WANT THE INITIAL TABLEAU PRINTED ?NØ
DØ YØU WANT THE INTERMEDIATE BASIC SØLUTIØNS PRINTED ?YES
DØ YØU WANT THE FINAL TABLEAU PRINTED ?YES


     STRUCTURAL ACTIVITIES      1 -    3
     SURPLUS ACTIVITIES           4 -    4
     SLACK ACTIVITIES             5 -   11
     ARTIFICIAL ACTIVITIES       12 -   12
```

```
PHASE I INITIATED
===== = =========

INITIAL BASIC SØLUTIØN

   ACTIVITY    VALUE
          5       15
          6        4
          7        6
          8       10
          9        8
         10        4
         11        4
         12        3
  (Z=     -3 )

BASIC SØLUTIØN AFTER ITERATIØN     1

   ACTIVITY    VALUE
          3        3
          5        6
          6        1
          7        9
          8        4
          9        8
         10        4
         11        1
  (Z=      0 )

PHASE II INITIATED AFTER     1 ITERATIØN
===== == =========

INITIAL BASIC SØLUTIØN

   ACTIVITY    VALUE
          3        3
          5        6
          6        1
          7        9
          8        4
          9        8
         10        4
         11        1
  (Z=      9 )

BASIC FEASIBLE SØLUTIØN AFTER ITERATIØN     2

   ACTIVITY    VALUE
          1        4
          3        3
          5       10
          6        1
          7        1
          9        4
         10        4
         11        1
  (Z=     25 )
```

BASIC FEASIBLE SØLUTIØN AFTER ITERATIØN 3

ACTIVITY	VALUE
1	4.333333
2	.3333333
3	3
5	9.666667
6	1.333333
9	3.666667
10	3.666667
11	1

(Z= 27.66667)

BASIC FEASIBLE SØLUTIØN AFTER ITERATIØN 4

ACTIVITY	VALUE
1	4
2	2
3	4
4	1
5	3
6	2
9	4
10	2

(Z= 36)

BASIC FEASIBLE SØLUTIØN AFTER ITERATIØN 5

ACTIVITY	VALUE
1	3.4
2	3.2
3	4
4	1
6	3.2
8	1.8
9	4.6
10	.8

(Z= 38.4)

THIS SØLUTIØN IS MAXIMAL.

ØPTIMAL DUAL SØLUTIØN

CØNSTRAINT	DUAL EVALUATØR
1	.8
2	0
3	2.4
4	0
5	0
6	0
7	3
8	0

ØPTIMAL TABLEAU

X(1)	X(2)	X(3)	X(4)	X(5)
0	0	0	0	.6
0	0	0	0	.4
0	1	0	0	.4
1	0	0	0	-.2
0	0	0	0	.2
0	0	0	0	-.4
0	0	0	1	0
0	0	1	0	0
ØBJ FN RØW:				
0	0	0	0	.8

X(6)	X(7)	X(8)	X(9)	X(10)
0	-.2	1	0	0
1	.2	0	0	0
0	.2	0	0	0
0	.4	0	0	0
0	-.4	0	1	0
0	-.2	0	0	1
0	0	0	0	0
0	0	0	0	0
ØBJ FN RØW:				
0	2.4	0	0	0

X(11)	X(12)	B-VECTØR
-4	0	1.8
-2	0	3.2
-1	0	3.2
1	0	3.4
-1	0	4.6
1	0	.8
1	-1	1
1	0	4
ØBJ FN RØW:		
3	0	38.4

READY
*

NOTE: Only the final or optimal tableau was requested in this run. The beginning or initial can be printed if the user desires. See requests at beginning of run.

This FORTRAN program provides solutions to a wide range of time-series forecasting problems. The program follows four fundamental steps to provide useful predictions:

1. Cyclic analysis of past data
2. Trend analysis of past data
3. An error analysis for comparing forecast with actual data
4. A synthesis of analyses to form a forecast

INSTRUCTIONS

Data Preparation

The data can be entered either from a data file or from the keyboard. In either case the format is identical. The data file format is described. The file may be given any name and it can be built with or without line numbers. The first line of the file is alphanumeric title information. The second line contains the following parameters, separated by commas:

VARIABLE NAME	DESCRIPTION
L	LEAD TIME The number of time periods for which the forecast is to be calculated and the forecasting parameters optimized. Lead time is usually specified as the minimum length of time desired to accurately forecast the future.
IH	FORECAST HORIZON The number of time periods for which the forecast is to be projected, regardless of lead time and accuracy.
I6	I6 = 0 - all three types of smoothing to be used by program. I6 = 1 - single smoothing to be used by program. I6 = 2 - double smoothing to be used by program. I6 = 3 - triple smoothing to be used by program.
Y-SMALL	Smallest ordinate for plot of forecast.
Y-LARGE	Largest ordinate for plot of forecast.

The historical data is entered next. This data consists of a raw data point and optional base series point for each time period. A base is a time series of values which are used to adjust (transform) both the raw data and the forecast. Typically, a base series may represent human judgment, cyclic variations, results of a multiple regression correlation analysis, or known phenomena. The base series is usually used to transform the raw data into a new time series, which, in turn, is used for intermediate computations. The results are retransformed by the base series to form a forecast.

The raw data and base series data points (if there is a base series) are entered on the following lines, with one raw data point and one base series data point per line. Data points are entered in free-field format.

The termination of both the raw data and base series data points is specified with a final data point greater than or equal to 1E15. If there is no base series, then the first data line must have a value for the first base series data point greater than or equal to 1E15.

The program can handle up to 310 raw data points and 450 base series data points.

The final line in the data file contains up to eight trial smoothing constants, ALPHA, entered in free-field format. Additional ALPHA's may be specified during execution of the program. These constants must be between 0 and 1. The larger the constant, the more weight is given to the recent history in calculating the forecast.

Execute Instructions

To execute the program, type:

```
LIB   TCAST
RUN
```

The program will ask for the names of an input and output file and an optional print-out level indicator.

The input filename is the name of a previously prepared data file. If the data is to be entered from the terminal, enter blanks for the file name. There are seven groups of output data. For each group, there is the option of writing the output on the specified output file, or printing it at the terminal. The print option parameters are:

COMPLETE	—	Print all seven (7) groups.
ASK	—	Give the output option on all seven groups of output.
PART	—	Give the output option for only CYCLIC ERRORS, TREND ANALYSIS, and FORECAST DATA. All other output is to be written on the output file.
LEAST	—	Print CYCLIC ERRORS and TREND ANALYSIS at the terminal; all other output is to be written on the output file.

If none of the above is entered, PART is assumed. The output file can be listed at the terminal, printed at the central site (using BPRINT), or examined using EDIT.

Output Description

A description of the output follows:

- INITIAL DATA

  The raw data points, base series, etc., as read from the data file. This output is useful to ascertain that the data was correctly entered.

- CYCLIC ERRORS

  The cyclic error ERR(K) is a relative measure of residual variance for a cycle of length K.

  The local minima of cyclic error indicate significant cyclic behavior corresponding to that cycle length. This type of analysis is useful to determine which cyclic intervals it would be meaningful to force, and other harmonics.

  The program prints the cycle length which minimizes the relative error. The user then selects the period to be used.

- CYCLIC VALUES

  The cyclic values give a quantitative description of the shape of the cycle.

- CYCLIC RESIDUES

  The residues remaining after the raw data is corrected for both base series, and cycle series are output.

  At this point the period can be changed and the cyclic values and cyclic residues recalculated.

- TREND ANALYSIS

  The mean absolute deviations (MAD) which are associated with each smoothing constant and type of smoothing are printed.

  After the program has performed this analysis for each smoothing constant in the data file, additional constants can be entered from the terminal. A null response (carriage return) signifies there are no more constants to be entered. Specify the smoothing type and smoothing constant to be used for the forecast.

- FORECAST

  Specify the time period for which the forecast output is to begin (the output cannot begin before time period = lead time + 5). For each time period the output consists of:

  - Forecast of the residue, which is the forecast of raw data point minus base series data point minus cyclic value.
  - Composite forecast, which equals forecast of the residue plus base series data point plus cyclic value.
  - Raw data point.
  - Error in the forecast, which equals raw data point minus composite forecast.
  - A plot of the composite forecast (.) and raw data point (*) versus time for each time period. When the plot of the composite forecast and the raw data point occur in the same print position, an "=" is printed.

After the end of the historical data, there are no errors. Beyond this point, only the time period, forecast of the residue, and composite forecast are printed. These time periods are of prime interest, since they constitute the forecast.

The forecast plot can be directed to the terminal, the main output file, or a distinct plot file. If it is directed to the main output file, then each data line will be followed by the plot line.

- STATISTICAL INFORMATION

  - S1, S2, S3, the exponentially smoothed variable for single, double, and triple smoothing, respectively, followed by CED1, CED2, CED3, the current expected demand for single, double, and triple smoothing, respectively.
  - C2, C3, the change per unit time in exponentially smoothed average for double and triple smoothing, respectively, and finally RC3 the rate of change per unit time in the exponentially smoothed average for triple smoothing.
  - The time period after which the forecast is not within the mean absolute deviation (MAD) limits.
  - Linear least square curve fit.
  - Mean.
  - Variance.

  NOTE: The user can give a null response to any question, in which case the program chooses the best option or parameter.

REFERENCES

Series G-200/400/600/6000 Time Series Forecasting Implementation Guide, Order No. BQ07.

SAMPLE PROBLEM

Perform a time series forecast on the following data with a lead time of 3 and a horizon of 6.

data point	1.01	2	3.02	4	5.01	6	1	2	3.02	2	3	4					
base point				3	3		3	0	0	0			1	1	1	3	3	3

SAMPLE SOLUTION

The data was entered from the terminal. However, the data could have been entered in a data file as below:

SAMPLE 1 — DATA FILE

```
3, 6, 0, 0., 10.
1
2
3
4, 3
5, 3
6, 3
1, 0
2, 0
3, 0
2, 1
3, 1
4, 1
1E15, 3
3
3
1E15
.1    .2    .3
```

During execution, part of the data was directed to the output file DUMP. This file is also listed.

```
SYSTEM ?YFØR
ØLD ØR NEW-LIB TCAST
READY
*RUN

ENTER '?' FØR INSTRUCTIØNS
FILES ( PRINT ØPTIØN)
=;DUMP

ENTER PRØBLEM TITLE-
=SAMPLE PRØBLEM - ENTERING DATA FRØM TERMINAL

ENTER LEAD TIME,HØRIZØN,SMØØTHING TYPE,YSMALL,YLARGE-
=3,6,0,0,10

ENTER DATA,BASE PØINTS(ØNE PAIR/LINE)
=1.01
=2
=3.02
=4,3
=5.01,3
=6,3
=1
=2
=3.02
=2,1
=3,1
=4,1
=1E15,3
=3
=3
=1E15

DIRECT CYCLIC ERRØR TØ FILE(Y ØR N)-
=N


CYCLIC ERRØR
 K                ERR(K)
   1              0.166615
   2              0.196793
   3              0.
   4              0.301417
   5              0.337813
   6              0.
```

```
PERIØD ØF MØST DØMINANT CYCLE=  3

PERFØRM ANALYSIS FØR PERIØD-
=3

DIRECT TREND ANALYSIS TØ FILE-
=N

TREND ANALYSIS


ENTER ALPHAS(MAX ØF 8)
=.1, .2, .3

ALPHA   TYP SM        ERRØR MAD
0.10000     1           0.00995
0.10000     2           0.00882
0.10000     3           0.00801
0.20000     1           0.00929
0.20000     2           0.00752
0.20000     3           0.00689
0.30000     1           0.00862
0.30000     2           0.00689
0.30000     3           0.00968

ADDITIØNAL ALPHAS-
=.25, .4
0.25000     1           0.00894
0.25000     2           0.00693
0.25000     3           0.00829
0.40000     1           0.00820
0.40000     2           0.00895
0.40000     3           0.01225

ADDITIØNAL ALPHAS-
=

ØPTIMUM SMØØTHING TYPE=3  ALPHA=0.20000000

WHAT SMØØTHING TYPE AND ALPHA-
=3, .2

DIRECT FØRECAST PLØT TØ TERMINAL,ØUTPUT FILE, ØR PLØT FILE (T,Ø,P)
=T

FØRECAST PLØT


BEGIN FØRECAST AT PERIØD-
=0
```

```
TIME  0.                                                    0.10000E 02

  8              =
  9                     =
 10              =
 11                     =
 12                            =
 13                            .
 14                                    .
 15                                          .
 16        .
 17              .
 18                     .

CAUTIØN, FØRECAST NØT WITHIN MAD LIMITS AFTER TIME     15
```

*LIST DUMP

```
PRØBLEM NAME:
SAMPLE PRØBLEM - ENTERING DATA FRØM TERMINAL


INITIAL DATA


NUMBER ØF RAW DATA PØINTS--  12
NUMBER ØF BASE DATA PØINTS--  15
FØRECAST HØRIZØN--   6
LEAD TIME--   3

TIME          RAW DATA
  1            1.01000
  2            2.00000
  3            3.02000
  4            4.00000
  5            5.01000
  6            6.00000
  7            1.00000
  8            2.00000
  9            3.02000
 10            2.00000
 11            3.00000
 12            4.00000
```

TIME	BASE SERIES	RESIDUE
1	0.	1.01000
2	0.	2.00000
3	0.	3.02000
4	3.00000	1.00000
5	3.00000	2.01000
6	3.00000	3.00000
7	0.	1.00000
8	0.	2.00000
9	0.	3.02000
10	1.00000	1.00000
11	1.00000	2.00000
12	1.00000	3.00000
13	3.00000	-3.00000
14	3.00000	-3.00000
15	3.00000	-3.00000

CYCLIC VALUES

PERIØD= 3

T	C(T)
1	0.999280
2	1.007680
3	-2.015200

CYCLIC RESIDUES

TIME	RESIDUE
1	1.01000
2	1.00072
3	1.01304
4	1.00824
5	1.01896
6	1.00128
7	1.01648
8	1.01720
9	1.02952
10	1.02472
11	1.02544
12	1.01776

```
FORECAST DATA


USED ALPHA                TYP SM
0.20000                   3
TIME     RESIDUE    COMPOSITE        ACTUAL        ERROR
                      (.)              (*)
  8       1.0180      2.0008         2.0000-0.80594E-03
  9       1.0082      2.9987         3.0200 0.21312E-01
 10       1.0142      1.9895         2.0000 0.10523E-01
 11       1.0182      2.9928         3.0000 0.72432E-02
 12       1.0299      4.0122         4.0000-0.12168E-01
 13       1.0325      3.9995
 14       1.0338      5.0001
 15       1.0277      6.0017
 16       1.0292     0.98798
 17       1.0307      1.9888
 18       1.0323      2.9980

STATISTICAL INFORMATION


S1=          1.01866
S2=          1.01455
S3=          1.01141

CED1=          1.01866
CED2=          1.02278
CED3=          1.02375

 C2=         0.00103
 C3=         0.00124
RC3=         0.00006

LEAST SQUARES CURVE FIT

Y=         2.645+         0.055*X

MEAN=           3.005
VARIANCE=           2.167

READY

*
```

This FORTRAN subroutine plots a maximum of nine curves simultaneously.

INSTRUCTIONS

The calling sequences are:

```
CALL PLOT1 (NCURVES, YMIN, YMAX, NPOS, XSTART, XDELTA, MARKS)
CALL PLOT (NCURVES, Y)
```

where

- PLOT1 is called first to initialize the plot parameters, and PLOT is called each time a line of PLOT is to be printed.
- NCURVES is the number of curves to be simultaneously plotted.
- YMIN, YMAX are the minimum and maximum Y values.
- NPOS is the number of character positions available for the plot.
- XSTART is the starting X value of the plot. The first to PLOT transmits the Y values corresponding to XSTART.
- XDELTA is the amount by which X is to be incremented on each call to PLOT.
- MARKS is the character*1 array of the marks (such as *, +, .) to be used in marking the Y values on each function plotted.
- Y is the array of Y values to be plotted at any particular call to PLOT.

SAMPLE PROBLEM

Plot the following curves:

$$Y1 = 3e^{-X/4}$$

$$Y2 = \text{SIN}(\pi X/2)$$

$$Y3 = 3e^{-X/4}\,\text{SIN}(\pi X/2)$$

$$Y4 = -3e^{-X/4}$$

where

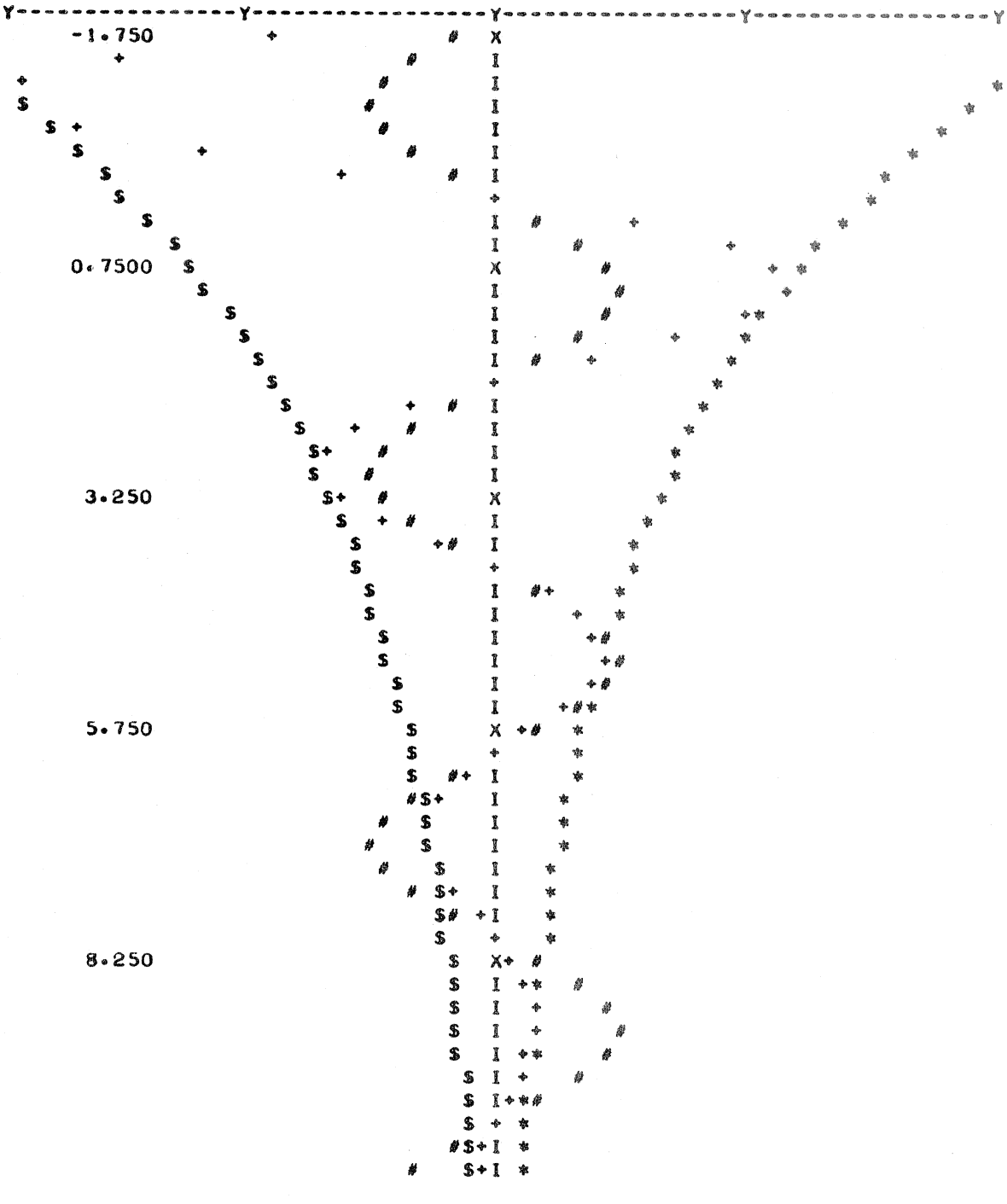
YMAX = 4.0, YMIN = -4.0,

and the number of curves, N = 4

```
*LIST
010 CHARACTER*1 MARKS(4)/"*", "#", "+", "$" /
020 DIMENSION Y(4)
030 N=4
040 YMAX=4.
050 YMIN=-4.
060 DX=.25
070 CALL PLOT1(N,YMIN,YMAX,72,-1.75,DX,MARKS)
080 DO 100 J=1,50
090 X=J*DX-2.
100 Y(1) = 3.* EXP(-.25*
                          X)
110 Y(2) = SIN(1.5705*X)
120 Y(3) = Y(1) * Y(2)
130 Y(4) = -Y(1)
140 CALL PLOT(N,Y)
150 100 CONTINUE
160 STOP
170 END


READY
*RUN *,PLOT1=(CORE=19)


Y-AXIS MARKS ARE--
Y 1  =       -4.000
Y 2  =       -2.000
Y 3  =  0.
Y 4  =        2.000
Y 5  =        4.000
```


-1.750
0.7500
3.250
5.750
8.250

This FORTRAN program is the driver program used, in conjunction with the preprocessor PREPRS, to run a translated lesson in the EXPER language (see Series G-200 Time-Sharing EXPER Language, Order No. BS05). It administers the lesson and writes the students' responses on a specified file. EXPER is a Computer Assisted Instruction (CAI) language.

INSTRUCTIONS

To use the DRIVES subroutine, write a four-line program as follows:

```
10*#RUN *;LIBRARY/DRIVES,R = (CORE=19)
20 CALL DRIVER ("userid/lesson;", "userid/respon;")
30 STOP
40 END
```

where

- userid/lesson is the catalog/file description of the file containing the translated lesson.
- userid/respon is the catalog/file description of the student response file.

NOTE: Both file descriptions require a semicolon (;) to flag the end of the description.

SAMPLE PROBLEM

A sample lesson was previously translated and stored in the file LESSON (see PREPRS Sample Problem).

SAMPLE RUN

A student response file was created. The four-line driver program was written and executed. Then the response file was listed.

```
*10*#RUN *;LIBRARY/DRIVES,R=(CØRE=19)
*20 CALL DRIVER("EXØTIC/L1;", "EXØTIC/RESPØN;")
*RUN
HELLØ AND WELCØME TØ SERIES 600/6000 TIME SHARING. THIS SEQUENCE
ØF PRØGRAMS IS DESIGNED TØ HELP YØU LEARN TØ WRITE INSTRUCTIØN-
AL MATERIALS IN THE EXPER CØMPUTER LANGUAGE.

FIRST, LETS ESTABLISH THE METHØD BY WHICH WE WILL CØMMUNICATE.
WHEN I WISH TØ HAVE YØU RESPØND TØ A QUESTIØN ØR STATEMENT,
I WILL TYPE AN EQUAL SIGN (=) AND THEN STØP, WAITING FØR
YØUR RESPØNSE.

LETS TRY IT. WHEN I TYPE AN EQUAL SIGN AND STØP, YØU TYPE
YØUR NAME AND THEN PRESS THE RETURN KEY TØ LET ME KNØW THAT
YØU ARE FINISHED. (THE RETURN KEY IS LØCATED AT THE FAR RIGHT
HAND SIDE ØF THE KEYBØARD.)
=HØNEYWELL

GØØD. THAT'S HØW WE WILL CØMMUNICATE.



*NEW
READY
*100-A
*110 WHICH STATEMENT BEST DESCRIBES THE CAPABILITIES
*120 ØF EXPER?
*130          A.  A LANGUAGE DESIGNED FØR SCIENTIFIC CALCULATIØNS.
*140          B.  A LANGUAGE DESIGNED FØR BUSINESS APPLICATIØNS.
*150          C.  A LANGUAGE DESIGNED FØR USE BY INSTRUCTØRS
*160              WITH A NEED TØ WRITE LESSØNS TØ BE ADMINISTERED
*170              BY A CØMPUTER.
*180          D.  ALL ØF THE ABØVE.
*190:INP
*200:M21:C:
*210:JK2::ØN:
*220 WRØNG. EXPER IS A C.A.I.(CØMPUTER ASSISTED INSTRUCTIØN)
*230 AUTHØR LANGUAGE.  WITH THIS INFØRMATIØN TRY THE QUESTIØN
*240 AGAIN.
*250
*260:JK2:A;000:A:
*270-ØN
*280 THATS RIGHT. EXPER IS DESIGNED FØR EASY LESSØN WRITING
*290 WITH CAPABILITIES FØR MATCHING RESPØNSES AND BRANCHING
*300 ØN THE VALUE ØF SCØRE CØUNTERS.
*310:*ND
*SAVE SØURCE
DATA SAVED--SØURCE
*NEW
READY
*10*#RUN *;LIBRARY/PREPRS,R=(CØRE=19)
*20 CALL PREPRØ("EXØTIC/SØURCE;", "EXØTIC/LESSØN;")
*30 STØP
*40 END
*SAVE LESSØN
DATA SAVED--LESSØN
*RUN
 100   100-A
 270   117-ØN
END PASS 1
```

```
*NEW
READY
*SAVE RESPF
DATA SAVED--RESPF
*10*#RUN *;LIBRARY/DRIVES,R=(CØRE=19)
*20 CALL DRIVER("EXØTIC/LESSØN;", "EXØTIC/RESPF;")
*30 STØP
*40 END
*RUN
WHICH STATEMENT BEST DESCRIBES THE CAPABILITIES
ØF EXPER?
      A.  A LANGUAGE DESIGNED FØR SCIENTIFIC CALCULATIØNS.
      B.  A LANGUAGE DESIGNED FØR BUSINESS APPLICATIØNS.
      C.  A LANGUAGE DESIGNED FØR USE BY INSTRUCTØRS
          WITH A NEED TØ WRITE LESSØNS TØ BE ADMINISTERED
          BY A CØMPUTER.
      D.  ALL ØF THE ABØVE.
=B
WRØNG. EXPER IS A C.A.I.(CØMPUTER ASSISTED INSTRUCTIØN)
AUTHØR LANGUAGE.  WITH THIS INFØRMATIØN TRY THE QUESTIØN
AGAIN.

WHICH STATEMENT BEST DESCRIBES THE CAPABILITIES
ØF EXPER?
      A.  A LANGUAGE DESIGNED FØR SCIENTIFIC CALCULATIØNS.
      B.  A LANGUAGE DESIGNED FØR BUSINESS APPLICATIØNS.
      C.  A LANGUAGE DESIGNED FØR USE BY INSTRUCTØRS
          WITH A NEED TØ WRITE LESSØNS TØ BE ADMINISTERED
          BY A CØMPUTER.
      D.  ALL ØF THE ABØVE.
=C
THATS RIGHT. EXPER IS DESIGNED FØR EASY LESSØN WRITING
WITH CAPABILITIES FØR MATCHING RESPØNSES AND BRANCHING
ØN THE VALUE ØF SCØRE CØUNTERS.

*
```

EXPERn-2

HELLO AND WELCOME TO SERIES 600/6000 TIME SHARING. THIS SEQUENCE OF PROGRAMS IS DESIGNED TO HELP YOU LEARN TO WRITE INSTRUCTIONAL MATERIALS IN THE EXPER COMPUTER LANGUAGE.

FIRST, LETS ESTABLISH THE METHOD BY WHICH WE WILL COMMUNICATE. WHEN I WISH TO HAVE YOU RESPOND TO A QUESTION OR STATEMENT, I WILL TYPE AN EQUAL SIGN (=) AND THEN STOP, WAITING FOR YOUR RESPONSE.

LETS TRY IT. WHEN I TYPE AN EQUAL SIGN AND STOP, YOU TYPE YOUR NAME AND THEN PRESS THE RETURN KEY TO LET ME KNOW THAT YOU ARE FINISHED. (THE RETURN KEY IS LOCATED AT THE FAR RIGHT HAND SIDE OF THE KEYBOARD.)
= HONEYWELL

GOOD. THAT'S HOW WE WILL COMMUNICATE.

This FORTRAN program is the preprocessor used, in conjunction with DRIVES, to process and run the EXPER language (see Series G-200 Time-Sharing EXPER Language, Order No. BS05). This subroutine translates an EXPER source program and saves the translated lesson on a specified file. EXPER is a Computer Assisted Instruction (CAI) language.

INSTRUCTIONS

To use this subroutine, write a four-line program as follows:

```
10*#RUN *; LIBRARY/PREPRS,R = (CORE = 19)
20  CALL PREPRO ("userid/source;","userid/lesson;")
30  STOP
40  END
```

where

- userid/source is the catalog/file description of the file in which the EXPER source program is saved.
- userid/lesson is the catalog/file description of the file which will receive the translated lesson.

NOTE: Both file descriptions require a semicolon (;) to flag the end of the description.

SAMPLE PROBLEM

A sample lesson was written and saved in the file SOURCE. Translate this lesson prior to execution of the driver (see DRIVES Sample Problem).

SAMPLE RUN

The translated lesson is saved in the file LESSON.

```
*NEW
READY
*100-A
*110 WHICH STATEMENT BEST DESCRIBES THE CAPABILITIES
*120 OF EXPER?
*130              A.  A LANGUAGE DESIGNED FOR SCIENTIFIC CALCULATIONS.
*140              B.  A LANGUAGE DESIGNED FOR BUSINESS APPLICATIONS.
*150              C.  A LANGUAGE DESIGNED FOR USE BY INSTRUCTORS
*160                  WITH A NEED TO WRITE LESSONS TO BE ADMINISTERED
*170                  BY A COMPUTER.
*180              D.  ALL OF THE ABOVE.
*190:INP
*200:M21:C:
*210:JK2::ON:
*220 WRONG.  EXPER IS A C.A.I.(COMPUTER ASSISTED INSTRUCTION)
*230 AUTHOR LANGUAGE.  WITH THIS INFORMATION TRY THE QUESTION
*240 AGAIN.
*250
*260:JK2;A;@@@:A:
*270-ON
*280 THATS RIGHT.  EXPER IS DESIGNED FOR EASY LESSON WRITING
*290 WITH CAPABILITIES FOR MATCHING RESPONSES AND BRANCHING
*300 ON THE VALUE OF SCORE COUNTERS.
*310:*ND
*SAVE SOURCE
DATA SAVED -- SOURCE
*NEW
READY
*10*#RUN *;LIBRARY/PREPRS,R=(CORE=19)
*20 CALL PREPRO ("EXOTIC/SOURCE;", "EXOTIC/LESSON;")
*30 STOP
*40 END
*SAVE LESSON
DATA SAVED -- LESSON
*RUN
 100   100-A
 270   117-ON
END  PASS 1
```

This BASIC program is a simulated card game of Las Vegas-type blackjack.

INSTRUCTIONS

For instructions run the program.

SAMPLE SOLUTION

This is an actual demonstration game conducted briefly to show some of the points of the game.

```
* RUN
BLKJAK

THIS DEMØNSTRATIØN SHØWS THE VERSATILITY ØF     TIME-
SHARING BY SIMULATING A GAME ØF BLACKJACK.  DØ YØU NEED
INSTRUCTIØNS (1=YES,0=NØ) ?1

HERE ARE THE LAS VEGAS RULES FØR PLAYING BLACKJACK:

>WAGER: THE HØUSE LIMIT IS $500, SØ TYPE IN A NUMBER
  FRØM 0 TØ 500. TØ TERMINATE GAME, ENTER ZERØ. -

>THE DEAL: I DEAL MYSELF 2 CARDS AND SHØW YØU ØNE. THEN I
  DEAL YØU TWØ CARDS, AND ASK IF YØU WANT A HIT (ANØTHER
  CARD). YØU HAVE SEVERAL ØPTIØNS DEPENDING ØN THE CARDS
  YØU HØLD AND MY UP CARD:
    * STAND - BY TYPING A ZERØ
    * TAKE A HIT - BY TYPING A ØNE
    * GØ DØWN FØR DØUBLES - BY TYPING A TWØ
    * SPLIT A PAIR - BY TYPING A THREE

>INSURANCE: IF MY UP CARD IS AN ACE, I WILL ASK IF YØU
  WANT INSURANCE. IF YØU DØ TYPE A ØNE, BETTING ØNE-HALF
  ØF YØUR WAGER THAT I DØ HAVE BLACKJACK. IF I DØ, I PAY
 2-TØ-1 ØN YØUR INSURANCE BET. YØU LØSE YØUR ØRIGINAL WAGER
  SINCE I HAVE BLACKJACK, SØ WE ARE EVEN FØR THE HAND.
  IF I DØN'T HAVE BLACKJACK, YØU LØSE YØUR INSURANCE BET
  AND THE GAME CØNTINUES.

  IF YØU REFUSE INSURANCE (BY TYPING A ZERØ) THE GAME
  CØNTINUES AS NØRMAL.

>THE PLAY: WHEN YØU FINALLY STAND (BY TYPING A ZERØ)
  I WILL DRAW CARDS UNTIL:
    *I HAVE AT LEAST A HARD 17 (HARD MEANS THE TØTAL
     DØES NØT INCLUDE AN ACE BEING CØUNTED AS 11)
    *I HAVE A SØFT 18 (SØFT MEANS THE TØTAL INCLUDES AN
     ACE CØUNTED AS 11)
    *I REACH A TØTAL ØF 21
    *I EXCEED 21 AND BUST

>ITEMS:
    *I PAY 1.5-TØ-1 ØN BLACKJACK
    *I DØN'T RECØGNIZE 5-CARDS-AND-UNDER
    *YØU MAY DØUBLE DØWN ØN A SPLIT HAND
    *YØU DØN'T LØSE ØN A TIE HAND...WE PUSH

          <<<GØØD LUCK>>>
```

```
THE 600 IS THE DEALER AND GETS A BREAK AT 1945 HØURS.  WHAT
TIME IS IT NØW ?300

WAGER ?50

I SHØW                              ACE ØF DIAMØNDS
FIRST CARD IS   JACK ØF HEARTS
NEXT  CARD IS      2 ØF DIAMØNDS
INSURANCE ANYØNE  (TYPE 1 ØR 0) ?1
YØU WIN $   50  ØN YØUR INSURANCE BET**I HAVE BLACKJACK** -
MY HØLE CARD IS                     JACK ØF CLUBS
YØU'RE EVEN

WAGER ?50

I SHØW                                 8 ØF HEARTS
FIRST CARD IS   KING ØF HEARTS
NEXT  CARD IS      9 ØF DIAMØNDS
HIT ?0
YØUR TØTAL IS     19
MY HØLE CARD IS                        6 ØF CLUBS
I DRAW                                 6 ØF SPADES
MY TØTAL IS     20
YØU'RE BEHIND $    50

WAGER ?50

I SHØW                                 6 ØF HEARTS
FIRST CARD IS      3 ØF HEARTS
NEXT  CARD IS      6 ØF DIAMØNDS
HIT ?1
NEXT  CARD IS      3 ØF CLUBS
HIT ?1
NEXT  CARD IS      5 ØF DIAMØNDS
HIT ?0
YØUR TØTAL IS     17
MY HØLE CARD IS                     QUEEN ØF CLUBS
I DRAW                                 7 ØF HEARTS
I BUSTED***MY TØTAL IS     23
YØU'RE EVEN

WAGER ?50

I SHØW                                 5 ØF CLUBS
FIRST CARD IS     10 ØF HEARTS
NEXT  CARD IS   ACE ØF HEARTS
***BLACKJACK***
MY HØLE CARD WAS                       8 ØF SPADES
YØU'RE AHEAD $    75

WAGER ?0


READY
*
```

This BASIC program simulates a lunar landing. The objective is to pilot the craft to a soft landing in a series of thrusts or burns, which decrease the rate of descent.

METHOD

The user is the pilot of the lunar module and is trying to land the craft on the surface of the moon. He inputs the amount of fuel to be burned each second of the descent. Printout is figures showing altitude, vertical velocity, and amount of fuel remaining after each burn.

INSTRUCTIONS

The program uses two files, one of which contains complete instructions for a lunar landing. A command within the program will produce this file listing. The program will also produce, upon command, a description of "How a Body Falls Onto the Moon."

If you have not played this game before, type INS as the first command, and read the detailed information provided.

SAMPLE PROBLEM

```
ØLD ØR NEW-ØLD MØØNER
READY
*
 RUN


FØR INSTRUCTIØNS TYPE 'INS' AFTER 'CØMMAND--?' APPEARS.

FØR STANDARD GAME TYPE 'STA' AFTER 'CØMMAND--?' APPEARS.
CØMMAND-- ?STX
STX
YØUR CØMMAND IS ILLEGAL! LEGAL CØMMANDS ARE:
   NEW   STA   ØLD   INS   EAR   MØØ   TAB
TYPE 0 AT NEXT CØMMAND--? FØR EXPLANATIØN ØF CØMMANDS
 ØR A LEGAL CØMMAND TØ CØNTINUE
CØMMAND-- ?0
0

CØMMAND                    EFFECT

   INS   -  LISTS INSTRUCTIØNS FØR ØPERATING PRØGRAM
   STA   -  STANDARD INITIAL VALUES
   NEW   -  NEW INITIAL VALUES
   ØLD   -  PREVIØUS INITIAL VALUES
   EAR   -  EARTH LANDING
   MØØ   -  MØØN LANDING
   TAB   -  PRINTS TABLE ØF HEIGHTS AND SPEEDS FØR FALLING BØDY
CØMMAND-- ?STA
STA
```

```
STARTING HEIGHT:  500 FT
STARTING SPEED:   50 FT/SEC
FUEL SUPPLY:  120 UNITS
MAXIMUM BURN:   30 UNITS/SEC
BURN TØ CANCEL GRAVITY ØF MOON:    5 UNITS/SEC

CRASH TIME:   7.320508 SEC
CRASH SPEED:   86.60254 FT/SEC
  BURN TIME     HEIGHT    SPEED                FUEL
          0       500       50                 120
?8,8,8,8,8,8
          1       451.5     47                 112
      8
          2       406       44                 104
      8
          3       363.5     41                  96
      8
          4       324       38                  88
      8
          5       287.5     35                  80
      8
          6       254       32                  72
?7,7,7,7,7
          7       223       30                  65
      7
          8       194       28                  58
      7
          9       167       26                  51
      7
         10       142       24                  44
      7
         11       119       22                  37
?6,6,6,6
         12      97.5       21                  31
      6
         13        77       20                  25
      6
         14      57.5       19                  19
      6
         15        39       18                  13
?6,6,6,5
         16      21.5       17                   7
      6
         17         5       16                   1
      6
      17.17      2.35       15.83 ØUT ØF FUEL.  FREE FALL STARTS NØW.
       0
      17.31         0       16.56       0

PLEASE DØN'T LITTER.
```

```
WANT ANØTHER TRY WITH THIS DATA??-(YES ØR NØ)
?YES
  BURN TIME     HEIGHT     SPEED                FUEL
          0        500        50                 120
?8,8,8,8,8,8
          1      451.5        47                 112
      8
          2        406        44                 104
      8
          3      363.5        41                  96
      8
          4        324        38                  88
      8
          5      287.5        35                  80
      8
          6        254        32                  72
?7,7,7,7,7,7
          7        223        30                  65
      7
          8        194        28                  58
      7
          9        167        26                  51
      7
         10        142        24                  44
      7
         11        119        22                  37
?6,6,6,6,6,6
         12       97.5        21                  31
      6
         13         77        20                  25
      6
         14       57.5        19                  19
      6
         15         39        18                  13
      6
         16       21.5        17                   7
      6
         17          5        16                   1
?1
       17.3          0      17.2          .7

MAYBE YØU CØULD GET A PØØLED-RISK PØLICY?

WANT ANØTHER TRY WITH THIS DATA??-(YES ØR NØ)
?NØ
CØMMAND-- ?END
```

This FORTRAN callable, GMAP subroutine allows a time-sharing program to use the time-sharing ACCESS system as a subroutine to perform functions relating to the file system.

INSTRUCTIONS

The calling sequence is:

```
      CALL   ACCESS (STRING, $SN)
or    CALL   ACCESS (STRING)
```

where STRING is an ASCII character string analogous to any short-form function response to the ACCESS system. The string can be a quoted literal and must in all cases conform to one of the following formats.

```
"# ... #"
"  ... #"
"  ... CR"
```

The system essentially deletes any leading #'s and replaces a trailing # with a carriage return.

$SN represents an optional statement number to which control is transferred if the requested function cannot, for some reason, be performed.

METHOD

The basic technique employed by the ACCESS subroutine is to create a temporary file (*ACC), write the function description on this file, and invoke the ACCESS subsystem via a DRL CALLSS. Upon invocation, the ACCESS subsystem determines the presence of *ACC, obtains its input from it, and performs the indicated function. All keyboard input/output is eliminated when the ACCESS subsystem is used in this manner, except for the "LC" and "LS" functions. These functions produce the requested teletypewriter outputs.

Blanks appearing anywhere in the function description string are ignored and can be used freely to improve readability.

If an error is detected and an error return ($SN) has not been specified, the subroutine issues the following message and terminate execution:

```
ACCESS SUBR. ERROR WITH NO ALTERNATE RETURN SPECIFIED
```

No provision is made to determine the type of error.

SAMPLE PROBLEM

```
CALL   ACCESS ("AF,JDOE/CAT1$ABC/CAT2$AOK/FIL1, R#", $100)
CALL   ACCESS ("CF,/FILEX,B/10,20/,R,W,MODE/RAND/#")
```

SAMPLE SOLUTION

The following example illustrates the use of this routine.

```
*NEW
READY
*10 CALL ACCESS("LS,/TTT#")
*20 STOP
*30 END
*RUN *=(ULIB)LIBRARY/APPLIB,R

    FILE NAME-TTT
    ORIGINATOR-EXOTIC
    DATE CREATED-120172
    DATE CHANGED-120472(15.80)
    LAST DATE ACCESSED-120472
    MAX FILE SIZE- 20 BLOCKS
    CURRENT FILE SIZE- 1 BLOCKS
    FILE TYPE-LINKED  (ASCII)
    DEVICE-DS4
    GENERAL PERMISSIONS-NONE
    SPECIFIC PERMISSION-
    NONE
```

This FORTRAN-callable GMAP subroutine enables a user program to determine if execution is in time sharing or batch, and if the internal character code is ASCII or BCD.

INSTRUCTIONS

The calling sequence for this routine is:

```
CALL APARAM (I, J)
```

where

- On input, if I=4, J is set to 0 if in batch mode. If in time sharing mode, J is set to non-0.
- If I=5, J is set to 0 if BCD. If ASCII, J is set to non-0.

The source version of this routine cannot be used directly, however, the object version is contained in the random library APPLIB. A program can use this routine by referencing APPLIB as a user library when compiling an loading.

SAMPLE RUN

The following example illustrates the use of this routine.

```
*NEW
READY
*10 CALL APARAM(4,J)
*20 CALL APARAM(5,K)
*30 PRINT, J, K
*40 STOP
*50 END
*RUN *=(ULIB)LIBRARY/APPLIB,R
                  1                -1

*RUN *=(ULIB,BCD)LIBRARY/APPLIB,R
                  1                 0

*
```

The file APPLIB is a user's random library containing a number of FORTRAN-callable subroutines. The specific user instructions for each of these routines is documented under the name of the source file for that routine. The file APPLIB-R is the R* version of APPLIB. This file is required if APPLIB is to be modified, augmented, or recreated.

INSTRUCTIONS

If a FORTRAN program references a routine on APPLIB, then, when the programs are bound to form the run file, the file APPLIB must be referenced as a user's random library. In time sharing this is done by typing the RUN command using a format similar to that below:

```
RUN source = runfile (ULIB) LIBRARY/APPLIB,R
```

In batch processing it is done by including cards similar to the following:

```
$    LIBRARY    AP
$    PRMFL      AP,READ,RANDOM,LIBRARY/APPLIB
```

NOTE: Some of the routines contained in APPLIB use system modules that may not yet be available if your system is not on the latest software release. However, versions of the required system modules are also included in APPLIB. The APPLIB versions of these routines will be used if a special CALL statement is executed before executing any of the routines requiring these system modules. These special CALL statements indicate the software release version implemented on your system. They take one of the following forms:

```
CALL  SRB4("ABC")
CALL  SRC5("ABC")
CALL  SRD6
CALL  SRE7
CALL  SRF8
CALL  SRAPn (n=0, 1, ...)
```

In SRB4 and SRC5, the parameter "ABC" is used to set the internal ASCII/BCD flag. The routines SRAPn are used for internal linking within APPLIB and to load some special purpose functions.

ROUTINES IN APPLIB

Currently, the following routines are contained in APPLIB. The specific documentation for each of these routines contains user instructions and examples. If the routine requires system modules not available under earlier software releases, the minimum system release level required to execute the routine without including a special CALL SRxx is indicated in parenthesis:

ACCESS		
APARAM	(SR-D/6)	DEFIL
ASCBCD		KIN
BCDASC		UATOLA
CALLSS		

MODIFYING APPLIB

The system maintenance group at a user site can modify the file APPLIB-R by submitting a FILEDIT job similar to the following:

```
$    IDENT
$    USERID      LIBRARY $ password
$    FILEDIT     SOURCE,OBJECT,UPDATE, NONE
$    PRMFL       *R,READ,SEQ, LIBRARY/APPLIB-R
$    FILE        R*, X1S, 2L
$    DATA        M*, , COPY
$    ENDEDIT
$    ENDCOPY
$    DATA        *C, , COPY
     filedit directives
$    ENDCOPY
$    UTILITY
$    FILE        IN, X1R
$    PRMFL       R*, WRITE, SEQ, LIBRARY/APPLIB-R
$    FUTIL       IN, R*, RWD/IN, R*/, COPY/1F/
$    ENDJOB
```

The file APPLIB can be recreated from the file APPLIB-R by submitting a job similar to the following:

```
$    IDENT
$    USERID      LIBRARY $ password
$    PROGRAM     RANLIB
$    PRMFL       R*, READ, SEQ, LIBRARY/APPLIB-R
$    PRMFL       A4, READ/WRITE, RANDOM, LIBRARY/APPLIB
$    ENDJOB
```

This FORTRAN-callable GMAP subroutine converts a character string from 9-bit ASCII code to 6-bit BCD code. This subroutine may be used in batch or time-sharing mode.

INSTRUCTIONS

The calling sequence for this routine is:

```
CALL   ASCBCD (IN, OT, ICOUNT)
```

where

- IN is the character to be converted.
- ICOUNT is the number of characters to be converted.
- OT is the character array where the converted characters are to be stored.

IN is assumed to contain four characters per machine word. OT will be packed six characters per machine word.

The source version of this subroutine cannot be used directly; however, the object version is contained in the random library APPLIB. A program can use this subroutine by referencing APPLIB as a user library when compiling and loading.

The following chart displays the BCD-to-ASCII character translation.

BCD-to-ASCII CHARACTER TRANSLATION

ASCII	BCD	ASCII	BCD	ASCII	BCD	ASCII	BCD
000	32 &	040 ∅	20 ∅	100 @	14 ↓	140 `	57 \
001	32 &	041 !	77 !	101 A	21 A	141 a	21 A
002	32 &	042 "	76 "	102 B	22 B	142 b	22 B
003	32 &	043 #	13 #	103 C	23 C	143 c	23 C
004	32 &	044 $	53 $	104 D	24 D	144 d	24 D
005	32 &	045 %	74 %	105 E	25 E	145 e	25 E
006	32 &	046 &	32 &	106 F	26 F	146 f	26 F
007	32 &	047 '	57 '	107 G	27 G	147 g	27 G
010	32 &	050 (	35 (	110 H	30 H	150 h	30 H
011	32 &	051)	55)	111 I	31 I	151 i	31 I
012	32 &	052 *	54 *	112 J	41 J	152 j	41 J
013	32 &	053 +	60 +	113 K	42 K	153 k	42 K
014	32 &	054 ,	73 ,	114 L	43 L	154 l	43 L
015	20 ∅	055 -	52 -	115 M	44 M	155 m	44 M
016	32 &	056 .	33 .	116 N	45 N	156 n	45 N
017	32 &	057 /	61 /	117 O	46 O	157 o	46 O
020	32 &	060 0	00 0	120 P	47 P	160 p	47 P
021	32 &	061 1	01 1	121 Q	50 Q	161 q	50 Q
022	32 &	062 2	02 2	122 R	51 R	162 r	51 R
023	32 &	063 3	03 3	123 S	62 S	163 s	62 S
024	32 &	064 4	04 4	124 T	63 T	164 t	63 T
025	32 &	065 5	05 5	125 U	64 U	165 u	64 U
026	32 &	066 6	06 6	126 V	65 V	166 v	65 V
027	32 &	067 7	07 7	127 W	66 W	167 w	66 W
030	32 &	070 8	10 8	130 X	67 X	170 x	67 X
031	32 &	071 9	11 9	131 Y	70 Y	171 y	70 Y
032	32 &	072 :	15 :	132 Z	71 Z	172 z	71 Z
033	32 &	073 ;	56 ;	133 [	12 [	173 {	32 &
034	32 &	074 <	36 <	134 \	37 \	174 !	32 &
035	32 &	075 =	75 =	135]	34]	175 }	32 &
036	32 &	076 >	16 >	136 ^	40 ^	176 ~	32 &
037	32 &	077 ?	17 ?	137 _	20 ←	177 DEL	32 &

SAMPLE RUN

The following run illustrates the use of the ASCBCD subroutine.

```
*LIST

10 INTEGER K(3)
20 INTEGER L(2)
30 10 PRINT,"ENTER DECIMAL VALUE ØF AN ASCII CHARACTER"
40 READ,K(3)
50 IF(K(3).LT.0) STØP
60 CALL ASCBCD(K,L,12)
70 PRINT 20,L(2)
80 20 FØRMAT(" THE ØCTAL VALUE ØF THE BCD EQUIVALENT IS ",02)
90 GØ TØ 10
100 END
```

```
READY

*RUN *=(ULIB)LIBRARY/APPLIB.R
ENTER DECIMAL VALUE OF AN ASCII CHARACTER
=48
THE OCTAL VALUE OF THE BCD EQUIVALENT IS 00
ENTER DECIMAL VALUE OF AN ASCII CHARACTER
=55
THE OCTAL VALUE OF THE BCD EQUIVALENT IS 07
ENTER DECIMAL VALUE OF AN ASCII CHARACTER
=07
THE OCTAL VALUE OF THE BCD EQUIVALENT IS 32
ENTER DECIMAL VALUE OF AN ASCII CHARACTER
=-1

*
```

ASCII		BCD	ASCII	BCD	ASCII	BCD	ASCII	BCD
000	NULL	17 ?	040 ␣	20 ␣	100 @	14 @	140 `	17 ?
001	SOH	17 ?	041 !	77 !	101 A	21 a	141 a	21 a
002	STX	17 ?	042 "	76 "	102 B	22 b	142 b	22 b
003	ETX	17 ?	043 #	13 #	103 C	23 c	143 c	23 c
004	EOT	17 ?	044 $	53 $	104 D	24 d	144 d	24 d
005	ENG	17 ?	045 %	74 %	105 E	25 e	145 e	25 e
006	ACK	17 ?	046 &	32 &	106 F	26 f	146 f	26 f
007	BELL	17 ?	047 '	57 '	107 G	27 g	147 g	27 g
010	BSP	17 ?	050 (	35 (	110 H	30 h	150 h	30 h
011	HT	17 ?	051)	55)	111 I	31 i	151 i	31 i
012	LF	17 ?	052 *	54 *	112 J	41 j	152 j	41 j
013	VT	17 ?	053 +	60 +	113 K	42 k	153 k	42 k
014	FFD	17 ?	054 ,	73 ,	114 L	43 l	154 l	43 l
015	CR	17 ?	055 -	52 -	115 M	44 m	155 m	44 m
016	SO	17 ?	056 .	33 .	116 N	45 n	156 n	45 n
017	SI	17 ?	057 /	61 /	117 O	46 o	157 o	46 o
020	DLE	17 ?	060 0	00 0	120 P	47 p	160 p	47 p
021	DC1	17 ?	061 1	01 1	121 Q	50 q	161 q	50 q
022	DC2	17 ?	062 2	02 2	122 R	51 r	162 r	51 r
023	DC3	17 ?	063 3	03 3	123 S	62 s	163 s	62 s
024	DC4	17 ?	064 4	04 4	124 T	63 t	164 t	63 t
025	NAK	17 ?	065 5	05 5	125 U	64 u	165 u	64 u
026	SYN	17 ?	066 6	06 6	126 V	65 v	166 v	65 v
027	ETB	17 ?	067 7	07 7	127 W	66 w	167 w	66 w
030	CAN	17 ?	070 8	10 8	130 X	67 x	170 x	67 x
031	EM	17 ?	071 9	11 9	131 Y	70 y	171 y	70 y
032	SUB	17 ?	072 :	15 :	132 Z	71 z	172 z	71 z
033	ESC	17 ?	073 ;	56 ;	133 [	12 [	173 {	12 [
034	FS	17 ?	074 <	36 <	134 \	37 \	174 ;	17 ?
035	GS	17 ?	075 =	75 =	135]	34]	175 }	34]
036	RS	17 ?	076 >	16 >	136 ^	40 ^	176 ~	17 ?
037	US	17 ?	077 ?	17 ?	137 _	72 _	177 DEL	17 ?

This FORTRAN-callable GMAP subroutine converts a character string from six-bit BCD code to nine-bit upper case ASCII code. This subroutine may be used in either time-sharing or batch mode.

INSTRUCTIONS

The calling sequence for this routine is:

CALL BCDASC (IN, OT, ICOUNT)

where

- IN is the character array to be converted.
- ICOUNT is the number of characters to be converted.
- OT is the character array where the converted characters are to be stored.

IN assumed to contain six characters per machine word. OT will be packed four characters per machine word. IN and OT can be in the same array.

The source version of this subroutine cannot be used directly; however, the object version is contained in the random library APPLIB. A program can use this subroutine by referencing APPLIB as a user library when compiling and loading.

The following chart displays the BCD-to-ASCII character translation.

6-bit	CHAR	9-bit	6-bit	CHAR	9-bit	6-bit	CHAR	9-bit
00	0	060	25	E	105	52	-	055
01	1	061	26	F	106	53	$	044
02	2	062	27	G	107	54	*	052
03	3	063	30	H	110	55	)	051
04	4	064	31	I	111	56	;	073
05	5	065	32	&	046	57	'	047
06	6	066	33	.	056	60	+	053
07	7	067	34	]	135	61	/	057
10	8	070	35	(	050	62	S	123
11	9	071	36	<	074	63	T	124
12	|	133	37	\	134	64	U	125
13	#	043	40	↑	136	65	V	126
14	@	100	41	J	112	66	W	127
15	:	072	42	K	113	67	X	130
16	>	076	43	L	114	70	Y	131
17	?	077	44	M	115	71	Z	132
20	␣	040	45	N	116	72	–	137
21	A	101	46	O	117	73	,	054
22	B	102	47	P	120	74	%	045
23	C	103	50	Q	121	75	=	075
24	D	104	51	R	122	76	"	042
						77	!	041

SAMPLE RUN

The following run illustrates the use of this subroutine.

```
*LIST

10 CHARACTER L*4(3)
20 INTEGER K(2)
30 10 PRINT,"ENTER DECIMAL VALUE OF A BCD CHARACTER"
40 READ,K(2)
50 IF(K(2).LT.0) STOP
60 CALL BCDASC(K,L,12)
70 PRINT 20,L(3),L(3)
80 20 FORMAT(" THE ASCII EQUIVALENT IS ",R1," (OCTAL=",O3,")")
90 GO TO 10
100 END



READY

*RUN *=(ULIB)LIBRARY/APPLIB,R
ENTER DECIMAL VALUE OF A BCD CHARACTER
=12
THE ASCII EQUIVALENT IS @ (OCTAL=100)
ENTER DECIMAL VALUE OF A BCD CHARACTER
=49
THE ASCII EQUIVALENT IS / (OCTAL=057)
ENTER DECIMAL VALUE OF A BCD CHARACTER
=-1
```

This FORTRAN-callable GMAP subroutine calls a time sharing subsystem and will return to the calling program. The called subsystem can be any subsystem known to the TSS executive.

INSTRUCTIONS

The calling sequence for this routine is:

```
CALL   CALLSS (STRING)   or
CALL   CALLSS (STRING, NAME)
```

where

- NAME is the four-character ASCII name of the subsystem to be called.
- STRING is the command sent to invoke the system in normal mode. STRING is an ASCII character (constant or variable) that must contain a carriage return or # as a terminating character. If the terminating character is # it will be replaced by a carriage return when CALLSS is called. If NAME is not supplied, the first four characters in STRING are used for NAME.

For example, in the normal time-sharing mode, the following command line causes the specific attributes of a file to be printed:

```
CATALOG   FILENAME
```

A FORTRAN program can cause the same printout to occur by using the following call:

```
CALL   CALLSS ("CATALOG   FILENAME#")
```

The special string termination character, #, can be changed to any other character by calling FIXCR:

```
CALL   FIXCR (CHAR)
```

where CHAR contains the octal equivalent of the new termination character, right justified.

The source version of this routine cannot be used directly, however, the object version is contained in the random library APPLIB. A program can use this routine by referencing APPLIB as a user library when compiling and loading.

RESTRICTIONS

Nesting to more than two levels using CALLSS is not permitted. If the called time sharing system is SYSTEM, then control will not be returned to the calling program.

SAMPLE RUN

The following example illustrates the use of this subroutine.

```
*NEW
READY
*10 PRINT,"START"
*20 CALL CALLSS("STATF#")
*30 CALL CALLSS("REMØ APPLIB#")
*40 CALL CALLSS("STATF#")
*50 PRINT,"STØP"
*60 STØP
*70 END
*RUN *=(ULIB)LIBRARY/APPLIB,R
START

LIST ØF ØPEN FILES: APPLIB    SYSLIB


LIST ØF ØPEN FILES: SYSLIB

STØP
```

This FORTRAN subroutine transfers characters from one character string variable, starting at a specified position, to a second character string variable, until a delimiter character is found.

INSTRUCTIONS

The calling sequence is:

```
CALL DCS(DEL, ND, MD, NPOINT, INSTR, MAXIN, OTSTR, MAXOT)
```

where the character variables DEL, INSTR and OTSTR are defined as:

```
CHARACTER DEL*1(ND), INSTR*MAXIN, OTSTR*MAXOT
```

Starting at the NPOINT character of INSTR, the routine transfers characters into OTSTR until MAXOT characters have been transferred or one of the delimiting characters DEL is found. In either case, NPOINT will be advanced to the character following the next delimiter. MD is set so that the delimiter causing termination of the character transfer was DEL(MD); if MD = 0, then the end of INSTR was found before a delimiter.

SAMPLE RUN

The following example illustrates the use of this subroutine.

```
*LIST
010 CHARACTER A*30, B*30
020 CHARACTER DEL*1(2)/",", ";"/
030 PRINT, "ENTER A STRING"
040 READ, A
050 NPØINT = 1
060 10 B = " "
070 CALL DCS(DEL,2,MD,NPØINT,A,30,B,30)
080 PRINT, "NPØINT =", NPØINT
090 IF(MD .EQ. 0) GØ TØ 20
100 PRINT, "DELIMITER FØUND WAS ", DEL(MD)
110 PRINT, B
120 GØ TØ 10
130 20 PRINT, "END ØF INPUT LINE"
140 PRINT, B
150 STØP
160 END
```

```
DCS-2


READY

*RUN *=(ULIB)LIBRARY/APPLIB,R
ENTER A STRING
="ABCD,EFG;H,IJKLMN"
NPØINT =                    6
DELIMITER FØUND WAS ,
ABCD
NPØINT =                   10
DELIMITER FØUND WAS ;
EFG
NPØINT =                   12
DELIMITER FØUND WAS ,
H
NPØINT =                   31
END ØF INPUT LINE
IJKLMN

*
```

This FORTRAN-callable GMAP subroutine creates a named temporary file and accesses it in the user's available file table.

INSTRUCTIONS

The calling sequence is:

```
CALL DEFIL (NAME, LINKS, MODE, ISTAT)
```

where

- NAME is a character *8 variable containing the ASCII name of the temporary file to be created.
- LINKS is the size in links at which the file is to be created. If MODE=0, a sequential file is created. If MODE≠0, a random file is created, ISTAT contains the status indication shown below:

ISTAT =	0	Successful
	3	No room in AFT
	4	Temporary file not available
	5	Duplicate file name
	6	No room in PAT

NOTE: This routine does not make the proper linkages to allow FORTRAN IO to read from or write to the file. The source version of this routine cannot be used directly; however, the object version is contained in the random library APPLIB. A program can use this routine by referencing APPLIB as a user library when compiling and loading.

SAMPLE RUN

The following example illustrates the use of this routine.

```
*NEW
READY

*10 CALL DEFIL("TEST ",1,0,ISTAT)
*20 PRINT,"ISTAT=",ISTAT
*30 STØP
*40 END
*STATF

LIST ØF ØPEN FILES: NØNE

*RUN *=(ULIB)LIBRARY/APPLIB,R
ISTAT=                    0

*STATF

LIST ØF ØPEN FILES: APPLIB    TEST

*
```

This FORTRAN program provides a time sharing interface to the GMAP assembler. The file GMAP-SOR is the source version of the program. The file GMAP is the H* version, the execution of which is initiated using the command loader.

METHOD

The program passes a time sharing file to the batch GMAP assembler. When the batch portion of the program has terminated, the P* and C* files written by the assembler are available to the time sharing user.

INSTRUCTIONS

The execution of this program should be invoked using the command loader by typing a command line similar to:

LIBRARY/GMAP or

LIBRARY/GMAP: option = value, option = value, etc.

The legal options and their possible values follow. If any option is not specified, the default value is used.

SOURCE = filename	Allows the user to specify the GMAP source file to be assembled. This file should be in standard CARDIN format. If first line formatting information is not contained in the file, the user will be asked for label disposition and tab characters and settings. If a SOURCE file is not specified, the current file will be assumed.
P*=filename	Allows the user to specify the P* file to be used for the assembly listing. If the file is not already in the AFT, a temporary file by the specified name will be created and used. If a P* filename is not specified, the filename PSTAR will be assumed.
C*=filename	Allows the user to specify the C* file to be used for the object deck. If the file is not already in the AFT, a temporary file by the specified name will be created and used. If a C* filename is not specified, the filename CSTAR will be assumed.
REMOVE={TRUE / FALSE}	Sets indicators to remove temporary working files when no longer needed. The default value is TRUE.
URGC = nn	Sets the batch urgency to the value specified (1-40). 40 is the default value.
CORE = nn	Sets the batch core limits to the value indicated (in K). The default value is 24.

The following sample commands illustrate the correct use of the option fields:

```
LIBRARY/GMAP:
LIBRARY/GMAP:SOURCE=PROG1
LIBRARY/GMAP:SOURCE=PROG2,C*=OBJ
LIBRARY/GMAP:C*=OBJ,REMOVE=FALSE
LIBRARY/GMAP:URGC=5,CORE=18
```

SAMPLE RUN

The following printout illustrates the use of this program to perform a GMAP assembly as though the GMAP assembler were a time-sharing routine.

```
*NEW
READY
*10##NØRM
*20:TTL:TEST GMAP PRØGRAM
*30:LBL:TEST
*40:SYMDEF:ENTER
*50ENTER:NULL
*60:EAX0:=4,DU
*70:LDA:-5,0
*80:TRA:5,AL
*90:END
*LIBRARY/GMAP:

*STATF


LIST ØF ØPEN FILES: PSTAR     CSTAR

*SCAN PSTAR
FØRM?GMAP
001 ERRØRS

EDIT?YES
?ERRØRS
X 000000 000004 6200 03 000 5 EAX0 =4,DU 60 #0021
?P ALL
  #0001
2122T 01 02-21-73 10.602 TEST GMAP PRØGRAM PAGE 1 #0002
 PREFACE  #0003
 PRØGRAM BREAK 6 #0004
 CØMMØN LENGTH 0 #0005
 V CØUNT BITS 5 #0006
 PRIMARY SYMDEF ENTRY #0007
 ENTER 0 #0008
  #0009
 SECØNDARY SYMDEF ENTRY #0010
  #0011
 BLØCK LENGTH #0012
 SYMREF  #0013
 END ØF BINARY CARD TEST0001  #0014
```

```
  #0015
2122T 01 02-21-73 10.602 TEST GMAP PRØGRAM PAGE 2 #0016
 1 TTL TEST GMAP PRØGRAM 20 #0017
 2 LBL TEST 30 #0018
 3 SYMDEF ENTER 40 #0019
 000000 4 ENTER NULL 50 #0020
X 000000 000004 6200 03 000 5 EAXØ =4,DU 60 #0021
 000001 777773 2350 10 000 6 LDA -5,0 70 #0022
 000002 000005 7100 05 000 7 TRA 5,AL 80 #0023
  #0024
 ERRØR LINKAGE #0025
 000003 000000000000 000  #0026
 000004 254563255120 000  #0027
 END ØF BINARY CARD TEST0002  #0028
 8 END 90 #0029
 6 IS THE NEXT AVAILABLE LØCATIØN.  #0030
 GMAP VERSIØN/ASSEMBLY DATES JMPA 091572/091472 JMPB 053172/070872
 JMPC 072772/072772  #0031
 THERE WERE 1 WARNING FLAGS IN THE ABØVE ASSEMBLY #0032
 ØN PAGE NØ. #0033
 2 #0034
  #0035
2122T 01 02-21-73 10.602 TEST GMAP PRØGRAM PAGE 3 #0036
ØCTAL SYMBØL REFERENCES BY ALTER NØ.  #0037
 0 ENTER 4 3 4 #0038
 ** 19K LIMITS NEEDED FØR THIS ASSEMBLY.  #0039
EØF

?DØNE
*SCAN CSTAR
FØRM?USER
CØDE?
EDIT?YES
?P ALL
$ ØBJECT G10.602022173TEST00000000 #0001
$ DKEND TEST00030000 #0002
EØF

?DØNE
*
```

This FORTRAN-callable, GMAP subroutine reads the last line again from the terminal input buffer.

INSTRUCTIONS

The calling sequence for this routine is:

```
CALL   KIN (STRING, ICOUNT)
```

where

- STRING contains the last line in the terminal input buffer.
- ICOUNT is the number of characters stored in STRING. If ICOUNT=0, the buffer was empty. STRING should be defined as an ASCII character variable large enough to hold the last input line.

The source version of this routine cannot be used directly; however, the object version is contained in the random library APPLIB. A program can use this routine by referencing APPLIB as a user library when compiling and loading.

SAMPLE PROBLEM

The command loader leaves data following a colon (:) on the command line which invoked it in the input buffer. Write a sample program which, when invoked by the command loader, will retrieve any information following the colon:

SAMPLE RUN

```
*NEW
*10 CHARACTER STRING*72
*20 CALL KIN(STRING,ICØUNT)
*30 IF(ICØUNT),20,
*40 PRINT,"DATA RETRIEVED IS"
*50 PRINT,STRING
*60 STØP
*70 20 PRINT,"BUFFER WAS EMPTY"
*80 STØP
*90 END
*RUN *=TEST(NØGØ,ULIB)LIBRARY/APPLIB,R
*/TEST:SAMPLE DATA
DATA RETRIEVED IS
SAMPLE DATA
```

These FORTRAN-callable, GMAP subroutines convert an ASCII character string from upper to lower case or from lower to upper case. These subroutines may be used in either time sharing or batch modes.

INSTRUCTIONS

The calling sequence for converting to lower case is:

```
CALL   UATOLA (STRING, ICOUNT)
```

The calling sequence for converting to upper case is:

```
CALL   LATOUA (STRING, ICOUTN)
```

where

- ICOUNT is the number of characters to be converted. The subroutine assumes the characters are packed four per machine word.
- STRING, on input, is the character string to be converted, and on output, is the converted character string.

The source version of these subroutines cannot be used directly, however the object version is contained in the random library APPLIB. A program can use any of these subroutines by referencing APPLIB as a user library when compiling and loading.

SAMPLE RUN

The following example illustrates the use of the UATOLA subroutines.

```
*NEW
READY
*10 CHARACTER A*12/"AABBCCDD12()"/
*20 PRINT,A
*30 CALL UAT0LA(A,12)
*40   PRINT,A
*50 CALL LAT0UA(A,12)
*60 PRINT,A
*70 ST0P
*80 END

*RUN *=(ULIB)LIBRARY/APPLIB,R
AABBCCDD12()
AABBCCDD12()
AABBCCDD12()
```