



DR. JOHN MANIOTES
COMPUTER TECHNOLOGY DEPT.
PURDUE UNIVERSITY
CALUMET CAMPUS
HAMMOND, IN 46323

DISCLAIMER

Although each program has been tested by its contributor, no warranty, express or implied, is made by the contributor or 1620 USERS Group, as to the accuracy and functioning of the program and related program material, nor shall the fact of distribution constitute any such warranty, and no responsibility is assumed by the contributor or 1620 USERS Group, in connection therewith.

1620 USERS GROUP PROGRAM REVIEW AND EVALUATION

(fill out in typewriter or pencil, do not use ink)

Program No. _____

Date _____

Program Name: _____

1. Does the abstract adequately describe what the program is and what it does? Yes ___ No ___
Comment _____
2. Does the program do what the abstract says? Yes ___ No ___
Comment _____
3. Is the Description clear, understandable, and adequate? Yes ___ No ___
Comment _____
4. Are the Operating Instructions understandable and in sufficient detail? Yes ___ No ___
Comment _____
Are the Sense Switch options adequately described (if applicable)? Yes ___ No ___
Are the mnemonic labels identified or sufficiently understandable? Yes ___ No ___
Comment _____
5. Does the source program compile satisfactorily (if applicable)? Yes ___ No ___
Comment _____
6. Does the object program run satisfactorily? Yes ___ No ___
Comment _____
7. Number of test cases run _____. Are any restrictions as to data, size, range, etc. covered adequately in description? Yes ___ No ___
Comment _____
8. Does the Program Meet the minimal standards of the 1620 Users Group? Yes ___ No ___
Comment _____
9. Were all necessary parts of the program received? Yes ___ No ___
Comment _____
10. Please list on the back any suggestions to improve the usefulness of the program. These will be passed onto the author for his consideration.

Please return to:

Mr. Richard L. Pratt
Data Corporation
7500 Old Xenia Pike
Dayton, Ohio 45432

Your Name _____

Company _____

Address _____

User Group Code _____

THIS REVIEW FORM IS PART OF THE 1620 USER GROUP ORGANIZATION'S PROGRAM REVIEW AND EVALUATION PROCEDURE. NONMEMBERS ARE CORDIALLY INVITED TO PARTICIPATE IN THIS EVALUATION.

11/09/64

b

PROGRAM LISTING

DESCRIPTION: The solution to the initial value problem

$$\frac{dy}{dx} = f(x,y), \quad y(x_0) = y_0$$

is numerically approximated and solution pairs (x,y) are printed on the typewriter at a specified printing increment, HPR, from $x=x_0$ to $x=XEND$. The solution can also be plotted on the typewriter if desired. NOTE: $x_0 < XEND$.

The Runge-Kutta-Gill Method may be used (HRK = 0.0) or the Runge-Kutta-Gill Method may be used to furnish starting values for Hamming's Method (HRK = 1.0). For a description of these methods refer to Mathematical Methods for Digital Computers by A. Ralston and H. Wilf.

The stepping increment is denoted by H and the solution value by Y1.

When computing by Hamming's Method, three numbers, T1, T2, and T3, must be provided by the user. These numbers control truncation error as described in the listing.

INPUT/OUTPUT: Input may be by cards or typewriter. Sample input for cards is included in the listing.

Output is on the typewriter and four pairs of sample outputs are included (one for Runge-Kutta-Gill and one for Hamming's).

SAMPLE PROBLEM: Four sample problems are described in the listing. In order to use the program deck, statement 100, which contains no GOTRAN statement, must be pulled out and replaced by the relevant function computation; samples of which are given in the listing.

Operating instructions are given in the listing.

Modifications or revisions to this program, as they occur, will be announced in the appropriate Catalog of Programs for IBM Data Processing Systems. When such an announcement occurs, users should order a complete new program from the Program Information Department.

```

C GOTRAN WITH SUBROUTINE TECHNIQUE USED FOR HAMMING'S METHOD AND/OR
C RUNGE KUTTA GILL METHOD FOR INITIAL VALUE PROB INVOLVING ONE
C FIRST ORDER DIFF. EQ.
C REFER TO GOTRAN OPERATING MANUAL FOR TYPEWRITER TAB SETTINGS
C PROGRAM STOPS ON RETURN TO STATEMENT 3
C HRK=0.0, RKG ONLY--, =1.0, HAM WITH RKG
C IN HAM, T LESS THAN T2 DOUBLE H, T GREATER THAN T1 HALVE H, T LESS
C THAN T3 PRINT 0.0 AND RETURN TO 3 AND STOP
C PLT=0.0, NO PLOT. =1.0, SOLUTION IS
C TRANSLATED BY YAXS AND THIS RESULT IS SCALED BY YSC AND THIS LAST
C RESULT PLOTTED ON THE TYPEWRITER. CHOOSE YSC SO (Y1+YAXS)/YSC IS IN
C 0 TO 49. IF NOT POSSIBLE, SOLUTION WILL BE PRINTED BUT NOT PLOTTED
C WHEN (Y1+YAXS)/YSC IS NOT IN THIS RANGE.
      DIMENSION YH(3)
3  READ ,HRK,PLT
   READ ,HPR,XEND,H
   PRINT ,H
   XPR=HPR
   READ ,X0,Y10
   IF (HRK) 31,30,31
31  READ ,T1,T2,T3
   PRINT ,T1,T2,T3
30  PRINT ,X0,Y10
   CP=0.0
   IF (PLT)301,301,900
C END DATA INPUT
C BEGIN RKG
301 X=X0
   Y1=Y10
   Q1=0.0
   K=1
   CK=1.0
1   U=X
   V=Y1
   C1=1.0
   GO TO 100
11  C1=H*F1
   TEMP=2.0*Q1
   TFMP=C1-TEMP
   D1=.5*TEMP
   W1=Y1+D1
   TFMP=.5*C1
   TFM1=3.*D1
   TFMP=TFM1-TEMP
   Q1=Q1+TEMP
   U=.5*H
   U=X+U
   V=W1
   C1=2.0
   GO TO 100
18  C1=H*F1
   TFMP=C1-Q1
   D1=.29289325*TEMP
   W1=W1+D1
   TFMP=.29289325*C1
   TFM1=3.0*D1

```

```

TFMP=TEM1-TEMP
Q1=Q1+TEMP
V=W1
CI=3.0
GO TO 100
25 CI=H*F1
TEMP=C1-Q1
D1=1.7071067*TEMP
W1=W1+D1
TEMP=1.7071067*C1
TFM1=3.0*D1
TEMP=TEM1-TEMP
Q1=Q1+TEMP
U=X+H
V=W1
CI=4.0
GO TO 100
32 CI=H*F1
TEMP=2.0*Q1
TEMP=C1-TEMP
D1=.16666667*TEMP
Y1=W1+D1
TFMP=.5*C1
TEM1=3.0*D1
TEMP=TEM1-TEMP
Q1=Q1+TEMP
X=X+H
PRNT=X-XPR
IF (PRNT)2,200,200
2 IF (HRK)1,1,37
37 YH(K) = Y1
DK=CK-3.0
IF (DK)40,510,510
40 K=K+1
CK=CK+1.0
GO TO 1
C END RKG
C BEGIN HAMMING
510 Z1=0.0
CK=4.0
HJ=0.0
X1=X0+H
Y11=0.0
Y12=0.0
U=X1
J=1
V = YH(J)
CI=5.0
GO TO 100
513 F11=F1
U=X1+H
J=2
V = YH(J)
CI=6.0
GO TO 100
518 F12=F1

```

```

U=2.0*H
U=X1+U
J=3
V = YH(J)
CI=7.0
GO TO 100
522 F13=F1
4 TEMP=2.0*F13
TEMP=TEMP-F12
TEM1=2.0*F11
TEMP=TEMP+TEM1
TEM1=1.3333333*H
TFMP=TEMP*TEM1
P1=Y10+TEMP
Q1=.92561983*Z1
Q1=P1-Q1
U=3.0*H
U=X1+U
V=Q1
CI=8.0
GO TO 100
531 R1=F1
TFMP=2.0*F13
TEMP=TEMP+R1
TFMP=F12-TEMP
TEM1=3.0*H
TEMP=TEM1*TEMP
J=3
TEM1 = 9.0*YH(J)
J=1
TEM1 = YH(J)-TEM1
TEMP=TEM1+TEMP
TEMP=.125*TEMP
C1=0.0-TEMP
Z1=P1-C1
J=3
IF (P1) 534,535,535
534 TY = 0.0 -P1
GO TO 536
535 TY = P1
536 TEST=TY-1.0
IF (TEST)537,537,539
537 T = .92561983*Z1
GO TO 540
539 T = 01/P1
T = .92561983*T
540 IF (T)532,533,533
532 T=0.0-T
533 TEST=T-T2
IF (TEST)552,5.5
5 TEST=T-T1
IF (TEST)538,538,548
538 Y13=Y12
Y12=Y11
Y11=Y10
J=1

```

```

L=2
M=3
Y10=YH(J)
YH(J)=YH(L)
YH(L)=YH(M)
YH(M)=.074380165*Z1
YH(M)=C1+YH(M)
F11=F12
F12=F13
X1=X1+H
X=2.0*H
X=X1+X
PRNT=X-XPR
IF (PRNT)543,541,541
541 J=3
Y1=YH(J)
GO TO 200
543 U=2.0*H
U=X1+U
J=3
V=YH(J)
C1=9.0
GO TO 100
546 F13=F1
GO TO 4
548 H=.5*H
PRINT ,H
TEST=H-T3
IF (TEST)549,550,550
549 HMIN=0.0
PRINT ,HMIN
GO TO 3
550 X0=4.0*H
X0=X1+X0
J=3
Y10=YH(J)
GO TO 301
552 IF (HJ)553,554,553
553 HJ=0.0
GO TO 5
554 TEST=4.0*H
TEMP = X0 + TEST
TEM1 =TEMP+TEST
TEST =X1-TEMP
IF (TEST) 5,556,556
556 TEST =TEM1-XEND
IF (TEST) 551,5,5
551 H =2.0*H
PRINT ,H
HJ=1.0
X0=2.0*H
X0=X1-X0
J=1
L=2
YH(L)=YH(J)
YH(J)=Y11

```

```

Y10=Y13
GO TO 510
C END HAMMING
C BEGIN PRINT
200 PRINT ,X,Y1
IF (PLT)201,201,901
201 TEST = X-XEND
IF (TEST)202,3,3
202 XPR=XPR+HPR
IF (HRK)1,1,205
205 TEST=CK-4.0
IF (TEST)2,543,2
C END PRINT
C SUBROUTINE FOR PLOT --REMOVE IF COMPILED IN FORTRAN WITHOUT FORMAT
C AND REPLACE BY 900 STOP AND 901 STOP
900 READ ,YAXS,YSC
Y1=Y10
901 YP=Y1+YAXS
YP=YP/YSC
IF (YP)904,902,902
902 YT=YP-49.
IF (YT)903,903,904
903 PLOT (YP,.)
04 IF (CP)201,905,201
05 CP=1.0
GO TO 301
C END PLOT
C SUBROUTINE FOR F1=F(U,V)
100
ZI=C1-2.0
IF (ZI)11,18,101
101 ZI=C1-4.0
IF (ZI)25,32,102
102 ZI=C1-6.0
IF (ZI)513,518,103
103 ZI=C1-8.
IF (ZI)522,531,546
C END SUBROUTINE
END

```

SAMPLE PROBLEM DATA

C THERE FOLLOWS 4 SAMPLE FUNCTION FORMULAS WHICH MUST REPLACE THE
C BLANK STATEMENT FOLLOWING 100 IN THE SOURCE DECK

```

100 F1= 1.0
100 F1= U
100 F1= V
100 TEMP=U*UZ
    F1=V*VZ
    F1=F1+TEMPZ

```

C SAMPLE DATA COMMON TO ALL FUNCTIONS USED

C PROB. NO. 1 -- RKG NO PLOT.

- 0.0
- 0.0
- 0.1
- 1.0
- .01
- 0.0
- 1.0

C PROB. NO. 2--RKG WITH PLOT

- 0.0
- 1.0
- 0.1
- 1.0
- .01
- 0.0
- 1.0
- 1.0
- .02

C PROB. NO. 3 --HAMMING NO PLOT

- 1.0
- 0.0
- 0.1
- 1.0
- .0125
- 0.0
- 1.0
- .00001
- .0000001
- .001

C PROB. NO. 4 --HAMMING WITH PLOT

- 1.0
- 1.0
- 0.1
- 1.0
- .0125
- 0.0
- 1.0
- .0001
- .0000001
- .001
- 1.0
- .02

X	Y
H= 1.000000E- 2	1.0000000
0.0	1.0999990
.10000000	1.1999980
.20000000	1.2999970
.30000000	1.3999960
.40000000	1.4999950
.50000000	1.5999940
.60000000	1.6999930
.70000000	1.7999920
.80000000	1.8999910
.90000000	1.9999900
1.0000000	
H= 1.000000E- 2	1.0000000
0.0	1.0999990
.10000000	1.1999980
.20000000	1.2999970
.30000000	1.3999960
.40000000	1.4999950
.50000000	1.5999940
.60000000	1.6999930
.70000000	1.7999920
.80000000	1.8999910
.90000000	1.9999900
1.0000000	
H= 1.250000E- 2	1.0000000E- 7 = T ₂
1.000000E- 5 = T ₁	1.000000E- 3 = T ₃
0.0	1.0000000
H= 2.500000E- 2	1.0999997
.10000000	1.2000000
.20000000	1.3000005
.30000000	1.4000006
.40000000	
H= 5.000000E- 2	1.5000006
.50000000	1.6500006
H= .10000000	1.7500006
.65000000	1.8500006
.75000000	1.9500006
.85000000	2.0500006
.95000000	
1.0500000	
H= 1.250000E- 2	1.000000E- 7 = T ₂
1.000000E- 4 = T ₁	1.000000E- 3 = T ₃
0.0	1.0000000
H= 2.500000E- 2	1.0999997
.10000000	1.2000000
.20000000	1.3000005
.30000000	1.4000006
.40000000	
H= 5.000000E- 2	1.5000006
.50000000	1.6500006
H= .10000000	1.7500006
.65000000	1.8500006
.75000000	1.9500006
.85000000	2.0500006
.95000000	
1.0500000	

$$\frac{dy}{dx} = 1, \quad y(0) = 1$$

→ no plot since YP > 49; choose different Ysc

→ no plot since YP > 49

$H=1.0000000E-2$
 0.0 1.0000000
 .10000000 1.0049160
 .20000000 1.0198320
 .30000000 1.0447480
 .40000000 1.0796640
 .50000000 1.1245800
 .60000000 1.1794960
 .70000000 1.2444120
 .80000000 1.3193280
 .90000000 1.4042440
 1.0000000 1.4991600
 $H=1.0000000E-2$
 0.0 1.0000000
 .10000000 1.0049160
 .20000000 1.0198320
 .30000000 1.0447480
 .40000000 1.0796640
 .50000000 1.1245800
 .60000000 1.1794960
 .70000000 1.2444120
 .80000000 1.3193280
 .90000000 1.4042440
 1.0000000 1.4991600
 $H=1.2500000E-2$
 $1.0000000E-5=71$ 1.0000000E-7=72 1.0000000E-3=73
 0.0 1.0000000
 $H=6.2500000E-3$
 .10000000 1.0053415
 $H=1.2500000E-2$
 $H=2.5000000E-2$
 .21250000 1.0229196
 $H=5.0000000E-2$
 .31250000 1.0491696
 $H=1.0000000$
 .46250000 1.1072946
 .56250000 1.1585446
 .66250000 1.2197946
 $H=2.0000000$
 .86250000 1.3722946
 1.0625000 1.5647946
 $H=1.2500000E-2$
 $1.0000000E-4=71$ 1.0000000E-7=72 1.0000000E-3=73
 0.0 1.0000000
 .10000000 1.0049617
 $H=2.5000000E-2$
 .20000000 1.0199616
 $H=5.0000000E-2$
 .30000000 1.0449615
 $H=1.0000000$
 .45000000 1.1012115
 .55000000 1.1512115
 .65000000 1.2112116
 .75000000 1.2812116
 .85000000 1.3612116
 .95000000 1.4512116
 $H=2.0000000$
 1.1500000 1.6612116

$$\frac{dy}{dx} = x, \quad y(0) = 1$$



$H=1.0000000E-2$
 0.0 1.0000000
 .10000000 1.1050784
 .20000000 1.2211980
 .30000000 1.3495191
 .40000000 1.4913240
 .50000000 1.6480302
 .60000000 1.8212027
 .70000000 2.0125722
 .80000000 2.2240500
 .90000000 2.4577497
 1.0000000 2.7160068
 $H=1.0000000E-2$
 0.0 1.0000000
 .10000000 1.1050784
 .20000000 1.2211980
 .30000000 1.3495191
 .40000000 1.4913240
 .50000000 1.6480302
 .60000000 1.8212027
 .70000000 2.0125722
 .80000000 2.2240500
 .90000000 2.4577497
 1.0000000 2.7160068
 $H=1.2500000E-2$
 $1.0000000E-5=71$ 1.0000000E-7=72 1.0000000E-3=73
 0.0 1.0000000
 $H=6.2500000E-3$
 .10625000 1.1120453
 .20625000 1.2290009
 .30625000 1.3582566
 $H=2.5000000E-2$
 .40625000 1.5011058
 .50625000 1.6589788
 $H=5.0000000E-2$
 .63125000 1.8798694
 .73125000 2.0775770
 $H=1.0000000$
 .88125000 2.4137999
 .98125000 2.6676615
 1.0812500 2.9482220
 $H=1.2500000E-2$
 $1.0000000E-4=71$ 1.0000000E-7=72 1.0000000E-3=73
 0.0 1.0000000
 .10000000 1.1051288
 .20000000 1.2213570
 $H=2.5000000E-2$
 .31250000 1.3667870
 .41250000 1.5105335
 .51250000 1.6693980
 $H=5.0000000E-2$
 .61250000 1.8449701
 .71250000 2.0390074
 .81250000 2.2534518
 .91250000 2.4904495
 1.0125000 2.7523726

$$\frac{dy}{dx} = y, \quad y(0) = 1$$

no plot since $Y_P > 49$, choose different y_{sc}

no plot since $Y_P > 49$

1.0000000E-2
0.0

1.7000000

H: 1.0000000E- 2
 0.0
 :10000000
 :20000000
 :30000000
 :40000000
 :50000000
 :60000000
 :70000000
 :80000000
 :90000000

1.0000000
 1.1112359
 1.2523885
 1.4383257
 1.6934312
 2.0616388
 2.6325588
 3.6246396
 5.7528798
 13.494457

$\frac{dy}{dx} = x^2 * y^2; y(0) = 1$

10

← characteristic overflow

ERROR E3
 1.0000000 1.3345425E+42

H: 1.0000000E- 2
 0.0
 :10000000
 :20000000
 :30000000
 :40000000
 :50000000
 :60000000
 :70000000
 :80000000
 :90000000

1.0000000
 1.1112359
 1.2523885
 1.4383257
 1.6934312
 2.0616388
 2.6325588
 3.6246396
 5.7528798
 13.494457

no plot since YP > 49; need different ysc

ERROR E3
 1.0000000 1.3345425E+42

H: 1.2500000E- 2
 1.0000000E- 5=71 1.0000000E- 7=72 1.0000000E- 3=73
 0.0 1.0000000

H: 6.2500000E- 3
 H: 3.1250000E- 3
 H: 6.2500000E- 3
 :10000000
 H: 1.2500000E- 2
 :20625000
 :30625000
 H: 2.5000000E- 2
 :41875000
 H: 1.2500000E- 2
 :50625000
 H: 6.2500000E- 3
 H: 3.1250000E- 3
 H: 1.5625000E- 3
 H: 3.1250000E- 3
 H: 6.2500000E- 3
 :60468750
 H: 1.2500000E- 2
 :70468750
 H: 6.2500000E- 3
 H: 3.1250000E- 3
 H: 1.5625000E- 3
 H: 7.8125000E- 4
 0.0

1.1113295
 1.2629955
 1.4530976
 1.7547470
 2.0949455
 2.6764518
 3.7143019

← stop since H < 73

H: 1.2500000E- 2
 1.0000000E- 4=71 1.0000000E- 7=72 1.0000000E- 3=73
 0.0 1.0000000

:10000000
 H: 2.5000000E- 2
 :21250000
 :31250000
 :41250000
 :51250000
 :61250000

1.1113658
 1.2733678
 1.4670806
 1.7347283
 2.1247757
 2.7385827

no plot since YP > 49

H: 1.2500000E- 2
 :70000000 3.6506861
 H: 6.2500000E- 3
 H: 3.1250000E- 3
 H: 6.2500000E- 3
 :80000000 5.8326228
 :90000000 14.211229
 H: 3.1250000E- 3
 H: 1.5625000E- 3
 H: 7.8125000E- 4
 0.0

← stop since H < 73