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Computer Programs for Estimation of the Flutter
and Divergence Boundaries from Random
Responses at a Subcritical Range

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CHŌFU, TOKYO, JAPAN

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Computer Programs for Estimation of the Flutter and Divergence Boundaries from Random Responses at a Subcritical Range*

Yasukatsu ANDO and Yuji MATSUZAKI **

Summary

This report describes a set of computer programs for NAL's method of estimation of the vibration characteristics and boundaries for flutter and divergence of an aeroelastic system subjected to stationary random noises. The programs listed here are those for the calculations of the autocoariance function of a time series and Jury's stability parameters of the characteristic equations of fourth and eighth orders, and those for the estimation of the stability boundary, frequency and damping ratio of the system.

概 要

定常な不規則擾乱による気流の乱れで励振された空力弾性系の応答から振動特性およびフラッタまたはダイバージエンス限界値を推定する航技研の方法による一連の計算プログラムを記載する。記載したプログラムは時系列の自己共分散関数の計算, 4次あるいは8次の特性方程式の係数,安定限界値および振動数と減衰率の推定に関するものである。

1. INTRODUCTION

A new efficient technique for estimating the stability boundary and vibration characteristics of an aeroelastic system has recently been developed in the National Aerospace Laboratory[1, 2]. The NAL method for the estimation consists of the following procedures. A time series of the response of the aeroelastic system to the gaussian random noise input is repre-

sented by an AR-MA process[1—3]. The order and coefficients of the process are estimated by Akaike's AIC minimum procedure[4]. Stability of the system is evaluated with the aid of Jury's stability criteria[5], in which the AR coefficients estimated are used. The stability boundary is estimated by fitting a straight line or a parabolic curve to the stability parameters which are plotted against the dynamic pressure. An equivalent system with viscous damping is introduced in order to evaluate the frequencies and damping ratios from the AR coefficients.

^{*} Received July 6, 1982

^{**} First Airframe Division

Refs. 1 and 2 give the details of the theoretical background of the analysis on which the program is based. Some information on the data analysis is also given in Ref. 3, especially, regarding the selection of values of the parameters used in the programs.

2. COMPUTER PROGRAMS

The set of the programs for the estimation (NAL ESBACS) includes six subprograms which are named CK, AKAIKE, JURY-CE4, JURY-CE4, JURY-CE4-EB and FRED. Except for the program AKAIKE the program listings will be given in the present report.

2.1) Program CK

This program calculates the mean, variance, standard deviation and auto-covariance function of a sampled data.

2.2) Program AKAIKE

This program is basically the same as a combination of the two sub-programs CANARM and AUTARM of Ref. 4. Using the autocovariance of the sampled data, this computes the order and coefficients of the AR-MA model. A number of modifications have been made in the two subprograms so that this program can be fitted directly to the objective of this set of the programs.

The essential modification introduced in to the AKAIKE program is the calculation of the AR and MA coefficients of a specific pair of orders of the ARMA process, instead of just evaluating those of the order at which AIC is minimum. Such a calculation is required for the three mode analysis mentioned in Refs. 1 and

2a. When the calculation is made for the MB-th order of the AR part, insert a statement between the 138th and 139th cards of the program CANARM of Ref. 4, like

138 C Dependence accepted when MIN-DIC is NEGATIVE IF (M1.EQ.MB+1) GO TO 6999

139 IF (X3(M1).GT.0.0) GO TO 110

2.3) Program JURY-CE4

This program computes Jury's stability parameters for the 4th order characteristic equation from the coefficients of the AR part. This program provides a preliminary information about the selection of the parameters of JURY-CE4-EB.

2.4) Program JURY-CE4-EB

This program computes Jury's stability parameters for the 4th order characteristic equation and estimates the flutter or divergence boundary.

2.5) Program JURY-CE8

This program computes Jury's stability parameters for the 8th order characteristic equation from the coefficients of the AR part.

2.6) Program FRED

This program computes the frequencies and damping ratios of an equivalent system of J-DOF with viscous damping from the coefficients of the AR part.

3. PROGRAM LISTS

```
Program listing for CK
              KOUGIKEN NO HOUHOU NI YURU FURATSUTA ARUIWA DAIBAAZENSU GENNAI
              SOKUDO DYOBI KUURIKIDANSEI TOKUSEI SUITEI NO KEISAN PUROGURAMU.
        C
              ESTIMATION OF BOUNDARY FOR FLUTTER OR DIVERGENCE AND AEROELASTIC
        C
        C
              CHARACTERISTICS AT SUBCRITICAL SPEEDS WITH THE AID UF NAL.S
              METHOD.
        C
              NAL ESBACS - 1 - 0001
        C
              C
              PROGRAM AUTOCOVARIANCE FUNCTION CK.
              PROGRAM CK CALCULATES MEAN, VARIANCE, STANDARD DEVIATION AND
        C
        C
              AUTUCOVARIANCE FUNCTION.
                    : DATA NO. FUR THE FIRST SET OF DATA,
        Č
              K O
              KAISU : DATA NO. FOR THE LAST SET OF DATA.
        C
              IBSTOP : MAXIMUM NO. DF DATA BLOCKS IN MAGNETIC TAPE WHICH ARE
                       TRANSFERED TO FILE.
                    : NUMBER OF DATA POINTS
              LAGHO : MAXIMUM LAG OF COVARIANCE
              YBAR
                    : MEAN
        C
                    : VARIANCE
              VAR
        C
              STD
                    : STANDARD DEVIATION
        C
              C(K): AUTOCOVARIANCE SEQUENCE OF Y(I) COMPUTATION.
000001
              INTEGER#2 IDATA(260)
000002
              DIMENSION Y( 8250)
000003
              DIMENSIUN C(501)
        CC
              INITIAL DATA
000004
              KO=1
000005
              KAISU=11
              IBSTOP=33
000006
000007
              N = 8192
800000
              LAGH0=200
000009
              IEND≈11
000010
              10UT=51
000011
              IEND=IEND+KAISU-KO
        CC
000012
              DO 50 IN=11. IEND
              INITIAL CONDITION INPUT AND PRINT DUT
        CC
000013
              IB=1
        CC
              READ(IN,1,END=40,ERR=40)(IDATA(1),1=1,257)
000014
000015
              CALL NOVALB(IDATA)
000016
              WRITE(6,220) IDATA(257)
000017
              WRITE(6,240)(IDATA(I), I=101,105)
000018
              WRITE(6,250) IDATA(106)
              WRITE(6,260)(IDATA(1),1=107,114)
000019
              WRITE(6,270) IDATA(15), IDATA(16), IDATA(17), IDATA(18), IDATA(19)
000020
              WRITE(6,280) IDATA(37)
000021
000022
              WRITE(6,3) 18
000023
              WRITE(6,2)(IDATA(1),1=1,260)
        CC
              DO 30 J=1, 18STUP-1
000024
000025
              18=15+1
        \mathsf{CC}
000026
              READ(IN,1,END=40,ERR=40)(IDATA(1),1=1,255)
000027
              10 = 0
000028
              DO 20 K=6,255
000029
              10 = 10 + 1
           20 IDATA(I@)=IDATA(K)-10000
000030
```

4

```
DO 10 K=1,250
000031
000032
               JK = 250 * (1b - 2) + K
003033
               Y(JK)=IDATA(K)#1.0
000034
            10 CONTINUE
000035
               IF(J.GE. 3) GU TO 120
000036
               WRITE(6,3) 18
000037
               WRITE(6,2)(IDATA(1),1=1,250)
000038
           120 CONTINUE
000039
            30 CONTINUE
000040
           40 CONTINUE
        \mathsf{CC}
               C(K): AUTOCOVARIANCE SEQUENCE OF Y(I) COMPUTATION , PUNCH OUT
        \epsilon c
000041
               AN=1.0/N
000042
               YBAR=0.
000043
               DO 101 I=1.N
               YBAR=YBAR+Y(1)
000044
000045
          101 CONTINUE
000046
               YBAR=YBAR*AN
000047
               RMM1=N-1
000048
               VAR=0.0
000049
               DO 105 I=1.N
000050
               Y(I)=Y(I)-YBAR
000051
               VAR=VAR+(Y(1)**2)
          105 CONTINUE
000052
000053
               VAR=VAR/RMM1
000054
               STD=SQRT(VAR)
000055
               WRITE(6,55) YBAR, VAR, STD
000056
               KL=LAGH0+1
               DO 110 K=1.KL
000057
000058
               C(K)=0.
000059
               J=K-1
000060
               JJ=N-j
               DO 121 I=1,JJ
000061
000062
               C(K)=C(K)+Y(I)*Y(I+J)
000063
          121 CONTINUE
000064
               C(K)=C(K)*AN
000065
          110 CONTINUE
000066
               WRITE(6,150) N.LAGHO
000067
               WRITE(6,60)
000068
               WRITE(6,130)(C(K),K=1,KL)
        \mathsf{CC}
000069
               WRITE(10UT)
                               N,LAGHO,(C(K),K=1,KL)
000070
               ENDFILE IOUT
               10UT=10UT+1
000071
000072
            50 CONTINUE
000073
               STOP
        \mathsf{CC}
000074
            1 FORMAT(200A2,57A2)
000075
             2 FORMAT(1H ,5X,2016)
000076
            3 FORMAT(1H ///, BLK=',15)
           55 FDRMAT(1H0, 'YBAR=', E15.8, 5X, 'VAR=', E15.8, 5X, 'STD=', E15.8//)
000077
000078
           60 FORMAT(1H0,4HC(K)//)
000079
          130 FORMAT(1H0,5E15.7)
080060
          150 FURMAT(1H0,2HN=,15,5x,6HLAGH0=,15)
000081
         220 FORMAT(1HO, 'TIME SERIES ANALYSIS', /, 1H , 'FILE NO.=', 12)
        C230 FORMAT(1H ,'MACH=',F10.3,/,1H ,'BPF=',[2,'-',[4,'(HZ)')
          240 FDRMAT(1H ,' EXP. NAME IS ',5A2,'.')
000082
000083
          250 FURMAT(1H ,' EXP.NO.=',16)
```

```
000084
          260 FORMAT(1H ,' UPERATOR NAME IS ',8A2,'.')
          270 FORMAT(1H ,' Y:M:D:H:M =',|2,':',|2,':',|2,':',|2)
000085
000086
          280 FORMAT(1H ,' SAMPLING TIME =', 16, 1*0.0001')
000087
              END
              SUBROUTINE NOVALB(ID)
INTEGER#2 ID(260)
000088
000089
                                  ,1,ID(101),1,10,IE)
000090
              CALL AECONV(ID
000091
              IF(IE.NE.O) WRITE(6,100) IE
000092
              1D(106)=1D(6)
000093
              CALL AECONV(ID(7),1,ID(107),1,16,IE)
000094
              IF(IE.NE.O) WRITE(6,100) IE
000095
              ID(257)=ID(257)+1
000096
              RETURN
         100 FORMAT(1H , * ***, AECONV-ERR CODE ', 17)
000097
000098
              END
```

Input example for program CK

```
// EXPAND USDK, RNO=S1, FILE='C01.M8001', DISP=NEW, RECFM=VBS
// EXPAND USDK, RNO=52, FILE='C01.M8002', DISP=NEW, RECFM=VBS
// EXPAND USDK, RNO=53, FILE='CO1.M8003', DISP=NEW, RECFM=VBS
// EXPAND USDK, RNO=54, FILE='C01.M8004', DISP=NEW, RECFM=VBS
// EXPAND USDK, RNO=55, FILE='C01.M8005', DISP=NEW, RECFM=VBS
// EXPAND USDK, RNO=56, FILE='C01.M8006', DISP=NEW, RECFM=VBS
// EXPAND USDK, RNO=57, FILE='CO1.M8007', DISP=NEW, RECFM=VBS
// EXPAND USDK, RNO=58, FILE='C01.M8008', DISP=NEW, RECFM=VBS
// EXPAND USDK, RNO=59, FILE='C01.M8009', DISP=NEW, RECFM=VBS
// EXPAND USDK, RNO=60, FILE='C01.M8010', DISP=NEW, RECFM=VBS
// EXPAND USDK, RNO=61, FILE='CO1.M8011', DISP=NEW, RECFM=VBS
// EXPAND MTR,RNO=11,FSEQ=02,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0
// EXPAND MTR,RNO=12,FSEQ=03,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0
// EXPAND MTR, RNO=13, FSEQ=04, BSIZE=514, RSIZE=514, RECFM=F, VOL=C01MT0
// EXPAND MTR,RNO=14,FSEQ=05,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0
// EXPAND MTR, RNO=15, FSEQ=06, BSIZE=514, RSIZE=514, RECFM=F, VOL=C01MT0
// EXPAND MTR, RNO=16, FSEQ=07, BSIZE=514, RSIZE=514, RECFM=F, VOL=C01MT0
// EXPAND MTR,RNO=17,FSEQ=08,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0
// EXPAND MTR, RNO=18, FSEQ=09, BSIZE=514, RSIZE=514, RECFM=F, VOL=C01MT0
// EXPAND MTR, RNO=19, FSEQ=10, BSIZE=514, RSIZE=514, RECFM=F, VOL=C01MT0
// EXPAND MTR, RNO=20, FSEQ=11, BSIZE=514, RSIZE=514, RECFM=F, VOL=C01MT0
// EXPAND MTR,RNO=21,FSEQ=12,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0
```

Output for pr TIME SERIES A FILE NG. 2 EXP. NAME IS EXP.NO. T OPERATOR NAM YAM: OH! MAN	Output for program CK		NO. = 2	EXP. NAME 1S SDIVER	EXP.NO. 1	OPERATOR NAME 15 E	Y:M:D:H:M =82: 1:14:10:36	SAMPLING TIME = 10+0.0001
---	-----------------------	--	---------	---------------------	-----------	--------------------	---------------------------	---------------------------

22 8 8 22 4 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	3301 3450 3450 3450 3450 3450 1240 1240 1240 1240 1240 1240 1240 124	-116 -314 1314 1314 1314 1314 1317 -372 -372 -378 -688 -688 -688 -688 -688 -78 -958 -143 -79
8 2 2 4 4 8 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	24 24 24 24 24 24 24 24 24 24 24 24 24 2	120 120 120 120 120 120 120 120
8 2 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	286 212 213 214 214 214 214 214 214 214 214 214 214	1296 61 11111 80486 61 611111 80486 61 61 61 61 61 61 61 61 61 61 61 61 61
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2001-1-1-000-1-1-1-1-1-1-1-1-1-1-1-1-1-1	1179 242 242 8908 8908 102 102 102 1150 1150 1150
82 7696 00 00 00 00 00	2566 1911 19161 19161 19161 19161 19161 19161 19161 19161 19161	200 219 219 888 888 633 633 1128 1128 1128 1481
8 2 2 4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	486044 486044 486044 486044 486044 48604 4	1018 1971 1971 1971 1971 1971 1971 1971 19
8 2 2 4 4 8 5 2 4 4 8 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	764 - 11 - 14 - 14 - 14 - 14 - 14 - 14 -	- 202 - 202 - 202 - 202 - 202 - 203 - 203
8224 8224 1284 1644 000 0000	1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	21
4 4 4 5 5 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	1	-269 137 137 1036 -1036 -257 -257 -257 -259 -259 -259
8 2 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	11	-296 -283 -95 116 640 1060 1060 1060 1060 1060 1060 1
2 8 2 2 4 8 8 2 2 4 4 8 8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	11 11 11 11 11 11 11 11 11 11 11 11 11	1080 1080 1080 1080 1080 1080 1080 1080
000 000 000 000 000 000 000 000 000 00	11	1306 1002 10094 1224 1440 1440 1440 1800 1800 1800
17696 00 150 00 00 00 00 00 00 00 00 00 00 00 00 0	1.2541 1.2541 1.2541 1.2542 1.	2365 1103 1103 1103 1103 1230 1314 1366 1366 1366
400004000000	1	-326 -322 14 34 14 329 1104 1106 265 197 -317 -290 -311 -356 -572 -541 -572 -572 -572 -572 -572 -572 -572 -572 -572 -572 -572
8 25 4 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-326 493 1104 493 1106 -317 -316 -316 -317 -572 -479 -903
8 57 4 9 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1	4 1 1 1 1 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4
441 441 688 600 600 600 600 600 600 600 600 600	1 1 2 2 3 4 3 4 3 4 4 4 4 4 4 4 4 4 4 4 4 4	1326 1628 1628 1628 1639 1639 1646 1646 1646 1646 1646 1646 1646 164
	4 1 2 2 2 2 3 1 1 1 2 2 2 2 2 1 1 1 2 2 2 2	-323 -51 1074 -370 -370 -172 -172 -172 -172 -172 -172 -172 -172
21316 18774 82 8 8224 82 8 8224 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	2 112 3012 1001 1001 1001 1001 1001 1001	9LK* 3 -323 - -316 -323 - -73 -51 1054 1074 1 540 471 -376 -370 - 260 -270 - -652 -638 - -964 -957 - -16 -36 - -964 -957 -
BLK-	₽ F K →	BLK -

0.1665021E+06	0.1660025F+06	0.1645139F+06	0.1620431E+06	0.1586197E+06
0.1542686E+06	0.1490338E+06	0.14295286+06	0.1360837E+06	0.12848596+06
0.1202214E+06	0.1113614E+06	0.10198216+06	0.9215475E+05	0.81965816+05
0.7149131E+05	0.60825816+05	0.5004212E+05	0.39237476+05	0.2848216E+05
0.17830836+05	0.7384602E+04	-0.2779025E+04	-0.1258939E+05	-0.2198728E+05
-0.3090762E+05	-0.3927509E+05	-0.4706778E+05	-0.5422934E+05	-0.6070909E+05
-0.6649331E+05	-0.7154306E+05	-0.7583550E+05	-0.7935719E+05	-0.8209569€+05
-0.8405306E+05	-0.8523000E+05	-0.8564225E+05	-0.8530350E+05	-0.8423562E+05
-0.8246475E+05	-0.8002187E+05	-0.7694962E+05	-0.7328200E+05	-0.6906794E+05
-0.6435750E+05	-0.5920853E+05	-0.5367062E+05	-0.4779847E+05	-0.4165991E+05
-0.3531494E+05	-0.2881254E+05	-0.2221621E+05	-0,1559312E+05	-0.9002184E+04
-0.2505771E+04	0.38429846+04	0.9992895E+04	0.1588988E+05	0.2148495E+05
0.2673279E+05	0.3159218E+05	0.3601644E+05	0.39980416+05	0.4346531E+05
0.4644116E+05	0,4888981E+05	0.5079353E+05	0.5214637E+05	0.5294353E+05
0.5318412£+05	0.5287600E+05	0.5202856E+05	0.5065366E+05	0.4877591E+05
0.46413626+05	0,4359484E+05	0.4035062E+05	0.3671803E+05	0.32723426+05
0.28403486+05	0.2380428E+05	0.1896919E+05	0.1394246E+05	0.8766062E+04
0.3486238E+04	-0.1853633E+04	-0.7209121E+04	-0.1253398E+05	-0.17785096+05
-0.2292034E+05	-0.2789898E+05	-0.3267329E+05	-0.37209196+05	-0.4148466E+05
-0.4546769E+05	-0.4913284E+05	-0.52447226+05	-0.5539037E+05	-0.5794562E+05
-0.6009534E+05	-0.6183031E+05	-0.6314466E+05	-0.6403409£+05	-0.6449819E+05
-0.6454031E+05	-0.6416962E+05	-0.6339600E+05	-0.6223437E+05	-0.6070266E+05
-0.58817976+05	-0.5660609E+05	-0.5410316E+05	-0.51314786+05	-0.4827950E+05
-0.4503128E+05	-0.4160197E+05	-0.3802931E+05	-0.3433931E+05	-0.3056403E+05
-0.2674283€+05	-0,2291128E+05	-0.1910365E+05	-0.1535287E+05	-0.1169184E+05
-0.81517116+04	-0.4761496£+04	-0.1548968E+04	0.1460653E+04	0.4246488E+04
0.6785668E+04	0.9060008€+04	0.11053636+05	0.12753506+05	0.1415006E+05
0.1523574E+05	0.1600637£+05	0.1646055E+05	0.1659994E+05	0.16429206+05
0.1595527E+05	0.15198706+05	0.14141346+05	0.1282813E+05	0.1126748E+05
0.94779346+04	0.74808246+04	0.53000706+04	0.29578306+04	0.4812393E+03
-0.2103482E+04	-0.47684268+04	-0.74856646+04	-0.10227336+05	-0.1296496E+05
-0.1567057E+05	-0.1831664F+05	-C.2087705E+05	-0.2332600E+05	-0.2563935E+C5

-0.2779432E+05 -0.2976973E+05 -0.3154750E+05 -0.3308991E+05 -0.3441806E+05 -0.3350409E+05 -0.3633534E+05 -0.3690369E+05 -0.3720441E+05 -0.36423E+05 -0.3648078E+05 -0.3648078E+05 -0.3569259E+05 -0.3720441E+05 -0.33723453E+05 -0.3187594E+05 -0.3648078E+05 -0.2816722E+05 -0.2601457E+05 -0.2368718E+05 -0.2120486E+05 -0.1858864E+05 -0.1586084E+05 -0.1304404E+05 -0.1016196E+05 -0.7739039E+04 -0.4298824E+04 -0.1366257E+04 0.1538302E+04 0.4391410E+04 0.7170004E+04 0.9851836E+04 0.1241776E+05 0.1684798E+05 0.1712477E+05 0.1923166E+05 0.2115436E+05 0.2287991E+05 0.2439743E+05 0.2569791E+05 0.2677450E+05

Program listing for JURY-CE4

```
KOUGIKEN NO HOOHOU NI YORU FURATSUTA ARUIWA DAIBAAZENSU GENKAI
               SOKUDO OYOBI KUURIKIDANSEI TOKUSEI SUITEI NO KEISAN PUROGURAMU.
        C
              ESTIMATION OF BOUNDARY FOR FLUTTER OR DIVERGENCE AND AEROELASTIC
        C
        C
              CHARACTERISTICS AT SUBCRITICAL SPEEDS WITH THE AID OF NAL,S
        C
              METHUD.
        C
              NAL ESBACS - 2 - 0003
        C
               *************************
              PROGRAM JURY-CE4 COMPUTES JURY'S STABILITY PARAMETERS FOR CHARACTERISTIC EQUATION OF 4TH ORDER.
        C
        C
        C
              THE PROGRAM INPUTS COEFFICIENTS OF AR PART.
        C
                     : DATA NO. FOR THE FIRST SET OF DATA, (USUALLY KO=1).
              K O
              KAISU : DATA NO. FOR THE LAST SET OF DATA.
        C
        Ċ
              00(KO): DYNAMIC PRESSURE.
              BO....B3 : AR COEFFICIENTS B(0)....B(3).
        C
        C
              * STABILITY PARAMETERS *
        C
        C
              G+1 AND G-1: G(1) AND G(-1)
        \mathsf{C}
              D5 : DET(X3-Y3), D6 : 2(B4-B0)-(B1-B3), D7 : (B1-B3)-2(B0-B4)
000001
              REAL#8
                         B4(21),B3(21),B2(21),B1(21),B0(21)
000002
              DIMENSION D1(21),D2(21),D5(21),D6(21),D7(21),Q0(42)
        CC
000003
              READ(5,556) KO, KAISU
000004
              WRITE(6,100)
000005
          555 CONTINUE
000006
              READ(5,500) 00(KO)
000007
              B4(K0)=1.0
000008
              READ(5,510)
                                B3(K0),B2(K0),B1(K0),B0(K0)
000009
              D1(K0) = B4(K0) + B3(K0) + B2(K0) + B1(K0) + B0(K0)
              D2(K0)=B4(K0)+B2(K0)+B0(K0)-B3(K0)-B1(K0)
000010
000011
              D5(K0) = (B0(K0) + 3) + (B4(K0) + 3) + (2.0 + B2(K0) + B4(K0) + B0(K0)
                 +B1(KO)*B3(KO)*B4(KO)+B0(KO)*B1(KO)*B3(KO))
                  -(B4(K0)**2+B3(K0)**2+B0(K0)*B4(K0)+B0(K0)*B2(K0))
                  *B0(K0)-(B2(K0)*B4(K0)+B1(K0)**2)*84(K0)
000012
              D6(K0)=2.0*(B4(K0)-B0(K0))-(B1(K0)-B3(K0))
              D7(K0)=(B1(K0)-B3(K0))-2.0*(B0(K0)-B4(K0))
000013
        CC
        CC
              PRINTS OUT :
000014
              WRITE(6,181) KO,00(KO),84(KO),83(KO),82(KO),81(KO),80(KO)
000015
              WRITE(6,182) KO,00(KO),D1(KO),D2(KO),D5(KO),D6(KO),D7(KO)
              PRINTS END
        CC
000016
              IF(KO.EO.KAISU) GO TO 558
000017
              K0=K0+1
000018
              GO TO 555
000019
          558 CONTINUE
000020
              STOP
000021
          100 FORMAT(1H0,10X, TABLE OF AR COEF. AND STABILITY PARAMETERS',//)
000022
          181 FORMAT(1H ,'NO.=',12,2X,'0=',F7.4,2X,' 84=',E13.5,2X,' B3=',
             * E13.5,2X,' B2=',E13.5,2X,' B1=',E13.5,2X,' B0=',E13.5,/)
          182 FORMAT(1H ,'NO.=',12,2X,'0=',F7.4,2X,' G+1=',E13.5,2X,' G-1=',
000023
                           D5=',E13.5,2X,' D6=',E13.5,2X,' D7=',E13.5,//)
             * E13.5,2X,1
          500 FORMAT(F10.0)
000024
          510 FORMAT(4D20.10)
000025
          556 FORMAT(215)
000026
000027
              FND
```

Input example for program JURY-CE4

1 7

0.697

-0.3870621811D+01 0.5719954687D+01 -0.3822636170D+01 0.9752230984D+00

0.724

-0.3870751267D+01 0.5715480661D+01 -0.3813428771D+01 0.9704536878D+00

0.772

-0.3876385509D+01 0.5730587338D+01 -0.3827188110D+01 0.9747041524D+00

0.802

-0.3869157356D+01 0.5711384821D+01 -0.3809756352D+01 0.9694635446D+00

0.823

-0.3877836368D+01 0.5734186824D+01 -0.3829655712D+01 0.9751856517D+00

0.836

-0.3873212193D+01 0.5722079326D+01 -0.3818873227D+01 0.9720295563D+00

0.847

-0.3886669923D+01 0.5758122654D+01 -0.3851425664D+01 0.9818472339D+00

Output for program JURY-CE4 TABLE UF AR COEF. AND STABILITY PARAMETERS

NO. = 1	0= 0.6970	A 4	0.100000+01	B3# -	-0.387060+01	B2=	0.572000+01	ਲ ₹	B1= -0.38226D+01	B0=	0.975220+00
NO.# 1	0= 0.6970	6+1=	0.19198E-02	6-1=	0.15388E+02	05=	0.42651E-06	90	0.15682E-02	-20	0.97539E-01
NO. = 2	Ø= 0.7240	84=	0.100000+01	83= -	-0.387080+01	82≖	0.571550+01	B1=	-0.38134D+01	B 0	0.970450+00
NO. = 2	0= 0.7240	6+1=	0.175436-02	G-1=	0.15370E+02	D5#	0.549676-06	19 9	0.177016-02	D7=	0.11642E+00
NO. = 3	0= 0.7720	8 t	0.100000+01	83	-0.38764D+01	B 2 m	0.573060+01	81≖	-0.382720+01	₩08	0.974700+00
NU.≖ 3	0= 0.7720	6+1=	0.17179E-02	6-1=	0.15409E+02	D5#	0.42440E-06	₽90	0.13943E-02	=10	0.997896-01
NO. = 4	0= 0.8020	84=	0.100000+01	83= -	-0.386920+01	82=	0.571140+01	B1 ≈	-0.38098D+01	80=	00+09+696*0
4 . ON	0= 0.8020	6+1=	0.19347E-02	6-1*	0.15360E+02	05*	0.52175E-06	₽90	0.16719E-02	≖20	0.12047E+00
NO. = 5	Q= 0.8230	84=	0.100000+01	B3= -	-0.387780+01	82≈	0.573420+01	81≖	-0.382970+01	₩0₩	0.975190+00
NO. = 5	0= 0.8230	6+1=	0.18804E-02	6-1=	0.15417E+02	D5*	0.24329E-06	9 90	0.14480E-02	D7#	0.978096-01
N .	Ø≠ 0.8360	₩ ₩	0.100000+01	83	-0.387320+01	82≈	0.572210+01	81#	B1= -0 ₃ 38189D+01	B 0	0.972030+00
9 *** ON	0= 0.8360	6+1=	0.20235E-02	6-1#	0.15386E+02	05*	0.27846E-06	-90	0.16019E-02	67	0.11028E+00
NO. = 7	0= 0.8470	84=	0.100000+01	83= -	-0.388670+01	82≖	0.575810+01	81#	-0.385140+01	80	0.981850+00
NO. = 7	0= 0.8470	6+1=	0.187436-02	G-1=	0.15478E+02	D5#	0.89669E-07	9 90	0.10613E-02	D7	0.715506-01

Program listing for JURY-CE4-EB

```
KOUGIKEN NO HOOHOU NI YORU FURATSUTA ARUIWA DAIBAAZENSU GENKAI
              SOKUDO OYOBI KUURIKIDANSEI TOKUSEI SUITEI NO KEISAN PUROGURAMU.
        C
              ESTIMATION OF BOUNDARY FOR FLUTTER OR DIVERGENCE AND AEROELASTIC
        C
        C
              CHARACTERISTICS AT SUBCRITICAL SPEEDS WITH THE AID OF NAL.S
              METHOD.
        C
              NAL ESBACS - 2 - 0004
        C
              C
        C
              PROGRAM JURY-CE4-FB COMPUTES JURY'S STABILITY PARAMETERS FOR
              CHARACTERISTIC EQUATION OF 4TH ORDER, AND ESTIMATE BOUNDARY.
        C
        C
              THE PROGRAM INPUTS THE EXPERIMENTAL AND PROCESS CONDITION. AND
              THE ORDER AND COEFFICIENTS OF AR PART.
        C
              BOUNDARY IS ESTIMATED FITTING A STRAIGHT LINE AND A PARABOLIC CURVE TO STABILITY PARAMETERS BY THE LEAST SQUARES METHOD.
        C
        C
              PARAMETERS ARE PLOTTED AND THE CRITICAL POINT IS GIVEN ON THE
        C
        C
              ABSCISSA.
              KO : DATA NO. FOR THE FIRST SET OF DATA, (USUALLY KO=1).
KAISU : DATA NO. FOR THE LAST SET OF DATA.
        C
        C
              QQ(KO): DYNAMIC PRESSURE.
        C
        C
              BO,...,B3 : AR COEFFICIENTS B(0),...,B(3).
        C
        C
              * STABILITY PARAMETERS *
        C
        C
              G+1 AND G-1: G(1) AND G(-1)
              F+I AND F-I: DET(XI+YI) AND DET(XI-YI) FOR I=1,3
        C
              F+2: (B1-B3)-2(B0-B4)
        C
000001
              REAL*8 SPMD(12), SBM( 3, 3), W
              MM OF X(MM,3) AND XXX(3,MM) AT DIMENSION IS SET TO A NUMERICAL
        C
              VALUE WHICH IS CALCULATED FROM KAISU-KO+1 .
        C
000002
              DIMENSION X(7.3),XX(3.3),XXX(3.7),B(3)
              DIMENSION FLMA(21), FLMAS(21)
000003
000004
              DIMENSION SX( 3, 3), SY( 3, 3), SHI( 3, 3)
                         B4(12),B3(12),B2(12),B1(12),B0(12)
              RFA! &R
000005
000006
              DIMENSION A4(12), A3(12), A2(12), A1(12), A0(12)
              DIMENSION CC(13), PD(12)
000007
              DIMENSION D1(21),D1S1(21),JD11(20),SDD11(20),0D1S1(20)
800000
                                 D1S2(21), JD12(20), SDD12(20), QD1S2(20)
000009
              DIMENSION
              DIMENSION D2(21), D2S1(21), JD21(20), SDD21(20), 0D2S1(20)
000010
                                 D2S2(21), JD22(20), SDD22(20), @D2S2(20)
              DIMENSION
000011
000012
              DIMENSION D5(21),D5S1(21),JD51(20),SDD51(20),0D5S1(20)
                                 D5S2(21), JD52(20), SDD52(20), QD5S2(20)
000013
              DIMENSION
000014
              DIMENSION D6(21), D6S1(21), JD61(20), SDD61(20), QD6S1(20)
                                 D6S2(21), JD62(20), SDD62(20), QD6S2(20)
000015
              DIMENSION
              DIMENSION D7(21),D7S1(21),JD71(20),SDD71(20),@D7S1(20)
000016
                                 D752(21), JD72(20), SDD72(20), @D752(20)
000017
              DIMENSION
              DIMENSION E5(21), E5S1(21), JE51(20), SDE51(20), QE5S1(20)
000018
                                 E5S2(21), JE52(20), SDE52(20), 0E5S2(20)
000019
              DIMENSION
              DIMENSION E6(21), E6S1(21), JE61(20), SDE61(20), OE6S1(20)
000020
                                 E6S2(21), JE62(20), SDE62(20), QE6S2(20)
000021
              DIMENSION
000022
              DIMENSION E7(21), E7S1(21), JE71(20), SDE71(20), 0E7S1(20)
000023
              DIMENSION
                                 E7S2(21), JE72(20), SDE72(20), QE7S2(20)
000024
              DIMENSION 00(42), WORK1(42), WORK2(42)
        CC
              READ(5,556) KO, KAISU
000025
              WRITE(6,100)
000026
              M = 4
000027
000028
              MIND=KAISU
        \mathsf{CC}
```

```
000029
           555 CUNTINUE
000030
               READ(5,500) 00(KO)
000031
               B4(K0)=1.0
000032
               READ(5,510)
                                 B3(K0),B2(K0),B1(K0),B0(K0)
        \mathsf{CC}
000033
               D1(K0)=B4(K0)+B3(K0)+B2(K0)+B1(K0)+B0(K0)
000034
               D2(K0)=B4(K0)+B2(K0)+B0(K0)-B3(K0)-B1(K0)
000035
               D7(K0) = (B1(K0) - B3(K0)) - 2.0 * (B0(K0) - B4(K0))
000036
                    W=(BO(KO)**3)+(B4(KO)**3)+(2.0*B2(KO)*B4(KO)*B0(KO)
              1
                  +B1(K0)*B3(K0)*B4(K0)+B0(K0)*B1(K0)*B3(K0))
                  -(B4(K0)**2+B3(K0)**2+B0(K0)*B4(K0)+B0(K0)*B2(K0))
                  *BO(KO)-(B2(KO)*B4(KO)+B1(KO)**2)*B4(KO)
000037
               E7(KO)= W
        CC
000038
               CC(1)=BO(KO)
000039
               CC(2) = B1(K0)
000040
               CC(3)=82(K0)
000041
               CC(4) = 83(K0)
000042
               CC(5)=B4(K0)
000043
               M0 = M - 1
               M1 = M + 1
000044
000045
               DO 95 1=1,M
000046
            95 PD(1)=0.0
000047
               CALL SAJT (M, M1, M0, CC, PD, SPMD, SBM, SX, SY, SHI)
000048
               D5(K0)=PD(1)
000049
               D6(KO)=PD(2)
000050
               E5(KO)=PD(3)
000051
               E6(K0)=PD(4)
        CC
               PRINTS OUT :
        CC
000052
               WRITE(6,181) KO,00(KO),B4(KO),B3(KO),B2(KO),B1(KO),B0(KO)
000053
               WRITE(6,182) KO,00(KO),D1(KO),D2(KO),D5(KO),D6(KO),D7(KO)
000054
               WRITE(6,682) KO,00(KO),D1(KO),D2(KO),E5(KO),E6(KO),E7(KO)
               PRINTS END
        CC
000055
               IF (KO.EQ.KAISU) GO TO 558
000056
               K0 = K0 + 1
               GO TO 555
000057
           558 CONTINUE
000058
000059
               WRITE(6,688)
        \mathsf{CC}
               LEAST SQUARES ESTIMATES :
000060
               JISU=1
000061
               JD11(K0)=0
000062
               SDD11(K0)=0.0
000063
               QD1S1(K0)=0.0
000064
               JD12(K0)=0
000065
               SDD12(KO)=0.0
000066
               0D1S2(K0)=0.0
000067
               IF(KO.LT.MIND) GD TO 130
000068
               WRITE(6,122)
          123 CONTINUE
000069
000070
               KSU=KO
               KSU1=KSU+1
000071
000072
               IJIS=JISU+1
000073
               DO 124 J=1,KSU
000074
               FLMA(1)=01(1)
               FLMAS(1)=0.0
000075
000076
          124 CONTINUE
```

```
FLMAS(KSU1)=0.0
000077
               CALL FLSE(KSU, KSU1, JISU, IJIS, 00, FLMA, FLMAS, X, XX, XXX, B, SD)
000078
               IF(SD.GT.0.0.AND.JISU.E0.1) GO TO 125
000079
080000
               GO TO 127
000081
         125
               JD11(K0)=1
               SDD11(KO)=SD
000082
000083
               DO 126 I=1,KSU1
               D1S1([)=FLMAS([)
000084
000085
          126 CUNTINUE
               0D1S1(K0)=00(KSU1)
000086
000087
          127 CONTINUE
               IF(SD.GT.0.0.AND.JISU.EQ.2) GD TO 128
000088
               GO TO 121
000089
          128 \ JD12(K0)=1
000090
               SDD12(KO)=SD
000091
000092
               DO 129 J=1,KSU1
               D1S2(I)=FLMAS(I)
000093
000094
          129 CONTINUE
               0D1S2(KO)=00(KSU1)
000095
          121 CONTINUE
000096
000097
               IF(JISU.EQ.2) GO TO 130
               JISU=JISU+1
000098
000099
               GO TO 123
          130 CONTINUE
000100
        \mathsf{CC}
        CC
               LEAST SQUARES ESTIMATES :
000101
               JISU=1
               JD21(K0)=0
000102
000103
               SDD21(K0)=0.0
               0D2S1(K0)=0.0
000104
000105
               JD22(K0)=0
000106
               SDD22(K0)=0.0
000107
               0D2S2(K0)=0.0
               IF(KO.LT.MIND) GO TO 140
000108
000109
               WRITE(6,132)
          133 CONTINUE
000110
000111
               KSU=K0
               KSU1=KSU+1
000112
000113
               IJIS=JISU+1
               DO 134 I=1,KSU
000114
000115
               FLMA(I)=D2(I)
               FLMAS(1)=0.0
000116
000117
           134 CONTINUE
               FLMAS(KSU1)=0.0
000118
               CALL FLSE(KSU, KSU1, JISU, IJIS, 00, FLMA, FLMAS, X, XX, XXX, B, SD)
000119
               IF(SD.GT.0.0.AND.JISU.EQ.1) GO TO 135
000120
               GD TO 137
000121
           135 JD21(K0)=1
000122
               SDD21(KO)=SD
000123
               DO 136 I=1,KSU1
000124
000125
               D2S1(1) = FLMAS(1)
           136 CONTINUE
000126
               QD2S1(KO)=QQ(KSU1)
000127
000128
           137 CONTINUE
               IF(SD.GT.O.O.AND.JISU.EQ.2) GO TO 138
000129
               GO TO 131
000130
           138 \ JD22(KO)=1
000131
               SDD22(KO)=SD
000132
```

```
000133
               DO 139 I=1.KSU1
               D2S2(1)=FLMAS(1)
000134
000135
           139 CONTINUE
000136
               @D2S2(KO)=@@(KSU1)
000137
           131 CONTINUE
000138
               IF(JISU.E0.2) GO TO 140
000139
               JISU=JISU+1
000140
               GO TO 133
000141
           140 CONTINUE
         \mathsf{CC}
               LEAST SQUARES ESTIMATES :
000142
               JISU=1
000143
               JD51(K0)=0
000144
               SDD51(KO)=0.0
000145
               @D5S1(K0)=0.0
000146
               JD52(K0)=0
000147
               SDD52(K0)=0.0
000148
               0D5S2(K0)=0.0
000149
               IF(KO.LT.MIND) GU TO 150
               WRITE(6,142)
000150
000151
           143 CONTINUE
000152
               KSU=KO
000153
               KSU1=KSU+1
000154
               IJIS=JISU+1
000155
               DO 144 [=1,KSU
000156
               FLMA(1)=D5(1)
000157
               FLMAS(1)=0.0
000158
           144 CONTINUE
000159
               FLMAS(KSU1)=0.0
000160
               CALL FLSE(KSU, KSU1, JISU, IJIS, 00, FLMA, FLMAS, X, XX, XXX, B, SD)
               IF(SD.GT.0.0.AND.JISU.E0.1) GO TO 145
000161
               GO TO 147
000162
          145 JD51(KO)=1
000163
000164
               SDD51(KO)=SD
               DO 146 I=1,KSU1
000165
000166
               D5S1(I)=FLMAS(I)
000167
          146 CONTINUE
000168
               0D5S1(K0)=00(KSU1)
000169
          147 CONTINUE
000170
               IF(SD.GT.O.O.AND.JISU.EQ.2) GO TU 148
000171
               GO TO 141
000172
          148 \ JD52(K0)=1
000173
               SDD52(KO)=SD
000174
               DD 149 I=1,KSU1
               D5S2(1)=FLMAS(1)
000175
000176
          149 CONTINUE
000177
               QD5S2(KO)=QQ(KSU1)
000178
          141 CONTINUE
000179
               IF(JISU.E0.2) GD TD 150
000180
               JISU=JISU+1
000181
               GD TD 143
          150 CONTINUE
000182
        \mathsf{CC}
               LEAST SQUARES ESTIMATES :
000183
               JISU=1
000184
               JD61(K0)=0
000185
               SDD61(K0)=0.0
000186
               006S1(K0)=0.0
```

```
000187
               JD62(K0)=0
000188
               SDD62(K0)=0.0
000189
               QD6S2(KO)=0.0
000190
               IF(KO.LT.MINU) GO TO 160
               WRITE(6,152)
000191
           153 CONTINUE
000192
000193
               KSU=KO
000194
               KSU1=KSU+1
000195
               IJIS=JISU+1
000196
               DO 154 !=1,KSU
000197
               FLMA(I)=D6(I)
               FLMAS(I)=0.0
000198
000199
           154 CONTINUE
000200
               FLMAS(KSU1)=0.0
000201
               CALL FLSE(KSU,KSU1,JISU,IJIS,@@,FLMA,FLMAS,X,XX,XXX,B,SD)
               IF(SD.GT.0.0.AND.JISU.E0.1) GO TO 155
000202
000203
               GO TO 157
           155 JD61(KO)=1
000204
               SDD61(KO)=SD
000205
               DO 156 I=1,KSU1
000206
000207
               D6S1(I)=FLMAS(I)
000208
           156 CONTINUE
               QD6S1(KO)=QQ(KSU1)
000209
000210
           157 CONTINUE
               IF(SD.GT.0.0.AND.JISU.E0.2) GD TO 158
000211
000212
               GD TO 151
000213
           158 \ JD62(KO)=1
000214
               SDD62(KO)=SD
               DO 159 [=1,KSU1
000215
000216
               D6S2(I)=FLMAS(I)
           159 CONTINUE
000217
000218
               QD652(KO)=QQ(KSU1)
000219
           151 CONTINUE
               IF(JISU.E0.2) GO TO 160
000220
000221
               JISU=JISU+1
000222
               GO TO 153
          160 CONTINUE
000223
        \mathsf{CC}
               LEAST SQUARES ESTIMATES :
        CC
               JISU=1
000224
000225
               JD71(K0)=0
000226
               SDD71(KO)=0.0
000227
               QD751(KO)=0.0
000228
               JD72(KO)=0
000229
               SDD72(KO)=0.0
               0D7S2(K0)=0.0
000230
000231
               IF(KO.LT.MIND) GO TO 170
               WRITE(6,162)
000232
000233
          163 CONTINUE
               KSU=KO
000234
               KSU1=KSU+1
000235
000236
               IJIS=JISU+1
               DO 164 I=1,KSU
000237
000238
               FLMA(I)=D7(I)
000239
              FLMAS(I)=0.0
000240
          164 CONTINUE
000241
              FLMAS(KSU1)=0.0
000242
              CALL FLSE(KSU, KSU1, JISU, IJIS, QQ, FLMA, FLMAS, X, XX, XX, B, SD)
```

IF(SD.GT.O.O.AND.JISU.EW.1) GO TO 165

000243

```
000244
               GO TO 167
000245
          165 \ JD71(K0)=1
000246
               SDD71(KO)=SD
000247
               DO 166 !=1,KSU1
000248
               D7S1(1)=FLMAS(1)
000249
          166 CONTINUE
000250
               @D7S1(K0)=00(KSU1)
000251
          167 CONTINUE
000252
               IF(SD.GT.O.O.AND.JISU.EQ.2) GD TO 168
000253
               GO TO 161
          168 \ JD72(K0)=1
000254
000255
               SDD72(KO)=SD
000256
               DO 169 I=1,KSU1
000257
               D7S2(1)=FLMAS(1)
          169 CONTINUE
000258
000259
               0D7S2(KO)=00(KSU1)
000260
          161 CONTINUE
000261
               IF(JISU.E0.2) GD TD 170
000262
               JISU=JISU+1
000263
               GO TO 163
          170 CONTINUE
000264
        CC
               LEAST SQUARES ESTIMATES :
        CC
000265
               JISU=1
000266
               JE51(KO)=0
000267
               SDE51(KO)=0.0
000268
               QE5S1(KO)=0.0
000269
               JE52(K0)=0
000270
               SDE52(KO)=0.0
000271
               0E5S2(KO)=0.0
000272
               IF(KO.LT.MIND) GO TO 450
               WRITE(6,442)
000273
000274
          443 CONTINUE
000275
               KSU=KO
000276
               KSU1=KSU+1
000277
               IJIS=JISU+1
000278
               DO 444 I=1,KSU
000279
               FLMA(I)=E5(I)
000280
               FLMAS(I)=0.0
000281
          444 CONTINUE
000282
               FLMAS(KSU1)=0.0
000283
               CALL FLSE(KSU, KSU1, JISU, IJIS, QQ, FLMA, FLMAS, X, XX, XXX, B, SD)
000284
               IF(SD.GT.O.O.AND.JISU.EQ.1) GO TO 445
000285
               GU TO 447
          445 JE51(KO)=1
000286
000287
               SDE51(KO)=SD
000288
               DO 446 I=1.KSU1
000289
               E5S1(I) = FLMAS(I)
000290
          446 CONTINUE
000291
               0E5S1(KO)=00(KSU1)
000292
          447 CONTINUE
000293
               IF(SD.GT.O.O.AND.JISU.EO.2) GO TO 448
               GO TO 441
000294
000295
          448 \text{ JE52(K0)=1}
000296
               SDE52(KO)=SD
000297
               DO 449 I=1,KSU1
               E5S2(1)=FLMAS(1)
000298
```

```
000299
           449 CONTINUE
               0E5S2(KO)=06(KSU1)
000300
000301
           441 CONTINUE
               IF(JISU.EQ.2) GO TO 450
000302
000303
               JISU=JISU+1
               GO TO 443
000304
000305
           450 CONTINUE
        \mathsf{CC}
        \mathsf{CC}
               LEAST SQUARES ESTIMATES :
000306
               JISU=1
               JE61(KO)=0
000307
000308
               SDE61(KO)=0.0
               0E6S1(KO)=0.0
000309
               JE62(KO)=0
000310
               SDE62(KO) = 0.0
000311
               0E6S2(K0)=0.0
000312
               IF(KO.LT.MIND) GO TO 460
000313
000314
               WRITE(6,452)
           453 CONTINUE
000315
               KSU=K0
000316
000317
               KSU1=KSU+1
               IJIS=JISU+1
000318
000319
               DO 454 I=1,KSU
               FLMA(1)=E6(1)
000320
000321
               FLMAS(1)=0.0
           454 CONTINUE
000322
000323
               FLMAS(KSU1)=0.0
               CALL FLSE(KSU, KSU1, JISU, IJIS, 00, FLMA, FLMAS, X, XX, XXX, B, SD)
000324
               IF(SD.GT.O.O.AND.JISU.EO.1) GO TO 455
000325
000326
               GD TD 457
           455 JE61(KO)=1
000327
               SDE61(KO)=SD
000328
               DO 456 I=1,KSU1
000329
               E6S1(I)=FLMAS(I)
000330
000331
          456 CONTINUE
               @E6S1(KO)=@@(KSU1)
000332
000333
           457 CONTINUE
               IF(SD.GT.O.O.AND.JISU.EW.2) GD TO 458
000334
000335
               GO TO 451
000336
           458 JE62(KO)=1
000337
               SDE62(KO)=SD
000338
               DO 459 [=1,KSU1
000339
               E6S2(I)=FLMAS(I)
000340
           459 CONTINUE
               0E6S2(KO)=Q0(KSU1)
000341
000342
           451 CONTINUE
000343
               IF(JISU.EQ.2) GO TO 460
000344
               JISU=JISU+1
000345
               GO TO 453
000346
           460 CONTINUE
        CC
        CC
               LEAST SQUARES ESTIMATES :
000347
               JISU=1
000348
               JE71(KO)=0
000349
               SDE71(KO)=0.0
000350
               QE7S1(KO)=0.0
000351
               JE72(KO)=0
000352
               SDE72(KO)=0.0
```

```
000353
               @E7S2(KO)=0.0
000354
               IF (KO.LT.MIND) GD TO 470
000355
               WRITE(6,462)
000356
          463 CONTINUE
000357
               KSU=KO
000358
              KSU1=KSU+1
000359
               IJIS=JISU+1
              D() 464 I=1,KSU
000360
000361
              FLMA(1)=E7(1)
000362
              FLMAS(1)=0.0
000363
          464 CONTINUE
000364
              FLMAS(KSU1)=0.0
000365
               CALL FLSE(KSU, KSU1, JISU, IJIS, 00, FLMA, FLMAS, X, XX, XXX, B, SD)
000366
               IF(SD.GT.0.0.AND.JISU.E0.1) GO TO 465
000367
               GD TO 467
000368
          465 JE71(K0)=1
000369
               SDE71(KO)=SD
000370
              DO 466 I=1,KSU1
              E7S1(I)=FLMAS(I)
000371
000372
          466 CONTINUE
000373
              QE7S1(KO)=QQ(KSU1)
          467 CONTINUE
000374
000375
               IF(SD.GT.0.0.AND.JISU.E0.2) GO TO 468
000376
              GD TO 461
000377
          468 JE72(KO)=1
000378
               SDE72(KO)=SD
000379
              DO 469 1=1,KSU1
000380
              E7S2(1)=FLMAS(1)
          469 CONTINUE
000381
000382
              0E7S2(KO)=Q0(KSU1)
000383
          461 CONTINUE
000384
              IF(JISU.E0.2) GD TD 470
000385
               JISU=JISU+1
000386
              GD TO 463
000387
          470 CONTINUE
        CC
              PRINT OUT
        C
        C
              WRITE(6,183) KO,00(KO),0D1S1(KO),SDD11(KO),0D1S2(KO),SDD12(KO)
        C
               WRITE(6,184) KO,00(KO),0D2S1(KO),SDD21(KO),0D2S2(KO),SDD22(KO)
        Ċ
              WRITE(6,185) K0,00(K0),0D5S1(K0),SDD51(K0),0D5S2(K0),SDD52(K0)
        C
              WRITE(6,186) KO,00(KO),0D6S1(KO),SDD61(KO),0D6S2(KO),SDD62(KO)
              WRITE(6,187) KO,00(KO),0D7S1(KO),SDD71(KO),0D7S2(KO),SDD72(KO)
        C
              WRITE(6,188) KO,00(KO),0E5S1(KO),SDE51(KO),0E5S2(KO),SDE52(KO)
        C
              WRITE(6,189) KO,00(KO),0E6S1(KO),SDE61(KO),0E6S2(KO),SDE62(KO)
        C
              WRITE(6,190) KO,00(KO),0E7S1(KO),SDE71(KO),0E7S2(KO),SDE72(KO)
                  GO TO 4320
        \mathsf{CC}
              PLUTS OF CHARACTERISTIC COEFFICIENT VS DYNAMIC PRESSURE :
000388
              L = KO
000389
              LN=1
              DO 195 [=1,KO
000390
000391
              B3(I)=B3(I)*(-1.0)
              B1(I)=B1(I)*(-1.0)
000392
000393
              A4(I)=SNGL(B4(I))
000394
              A3(I) = SNGL(B3(I))
000395
              A2(1)=SNGL(B2(1))
000396
              A1(I) = SNGL(B1(I))
000397
              AO(I) = SNGL(BO(I))
```

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195 CONTINUE
000398
              CALL PLUT(LN,L,00,A3,0.5,1.0,3.80,3.90,
000399
             #92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
             * DYNAMIC PRESSURE
                         VS O(KG/CM2)
             #28H B3
              CALL PLUT(LN,L,00,A2,0.5,1.0,5.60,5.80,
000400
             *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
             * DYNAMIC PRESSURE
                         VS Q(KG/CM2)
             *28H 82
              CALL PLOT(LN,L,06,A1,0.5,1.0,3.80,3.86,
000401
             *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
             * DYNAMIC PRESSURE
                         VS Q(KG/CM2)
             *28H B1
              CALL PLOT(LN,L,00,A0,0.5,1.0,0.95,1.00,
000402
             *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
             * DYNAMIC PRESSURE
             *28H B0
                        VS Q(KG/CM2)
        CC
        CC
              PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
        CC
000403
              L=2*(K0+1)
              LN=2
000404
              IF(0D1S1(KO),E0.0.0.AND.0D1S2(KO),E0.0.0) GO TO 254
000405
              IF(@D1S1(KO).E@.O.O) GO TO 253
000406
000407
              DO 252 1=1,KO
              WDRK1([)=D1([)
000408
000409
              IK=I+(KO+1)
000410
              WORK1(IK) = D1S1(I)
000411
              00(1K) = 00(1)
000412
          252 CONTINUE
              WDRK1(KO+1)=0.0
000413
000414
              WORK1(L)=0.0
              QQ(KO+1)=QD1S1(KO)
000415
000416
              00(L)=00(K0+1)
              CALL PLOT(LN,L,00,WORK1,0.5,1.0,0.0,0.5E-02,
000417
             *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
             * DYNAMIC PRESSURE (0:1,*:F)
             *28H G+11
                        VS @(KG/CM2)
          253 CONTINUE
000418
              IF(QD1S2(KO), EQ. 0.0) GO TO 254
000419
000420
              DO 255 [=1,KO
              WORK2(1)=D1(1)
000421
              IK = I + (KO + 1)
000422
              WORK2(IK)=D1S2(I)
000423
000424
              00(1K)=00(1)
000425
          255 CONTINUE
000426
              WORK2(KO+1)=0.0
              WORK2(L)=0.0
000427
000428
              00(K0+1)=0D1S2(K0)
              00(L) = 00(K0+1)
000429
              CALL PLOT(LN, L, 00, WORK 2, 0.5, 1.0, 0.0, 0.5E-02,
000430
             *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
             * DYNAMIC PRESSURE (0:1, *:F)
                           VS Q(KG/CM2)
             *28H G+12
          254 CONTINUE
000431
              PLOTS END
        \mathsf{CC}
        CC
              PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
        CC
```

```
L=2 (KO+1)
000432
000433
              LN=2
               IF(QD2S1(KO).EQ.O.O.AND.GD2S2(KO).EQ.O.O) GO TO 264
000434
               IF(9D2S1(KO).E0.0.0) GO TO 263
000435
              DO 262 1=1.KO
000436
               WORK1(I)=D2(I)
000437
               IK = I + (KO+1)
000438
000439
               WORK1(IK) = D2S1(I)
000440
               00(1K)=00(1)
000441
          262 CONTINUE
000442
               WDRK1(KO+1)=0.0
000443
               WORK1(L)=0.0
000444
               00(K0+1)=0D2S1(K0)
000445
               QQ(L) = QQ(KO+1)
               CALL PLOT(LN, L, 00, WORK1, 0.5, 1.0, 0.0, 0.2E+02,
000446
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (0:1,*:F) .
                         VS @(KG/CM2)
              #28H G-11
000447
          263 CONTINUE
000448
               1F(@D2S2(KO).E@.O.O) GO TO 264
               DD 265 I=1,KO
000449
               WURK2(1)=D2(1)
000450
000451
               1K=1+(KO+1)
000452
               WORK2(IK)=D2S2(I)
000453
               00(1K) = 00(1)
          265 CONTINUE
000454
000455
               WORK2(KO+1)=0.0
000456
               WORK2(L)=0.0
               @@(KO+1)=@D2S2(KO)
000457
000458
               00(L) = 00(K0+1)
               CALL PLOT(LN,L,00,WORK2,0.5,1.0,0.0,0.2E+02,
000459
              *92H PREDICTION OF FLUTTER UNSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (0:1, *: F) ,
              *28H G-12
                            VS @(KG/CM2)
          264 CONTINUE
000460
               PLOTS END
        CC
        \mathsf{CC}
               PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
        CC
000461
               L=2*(KO+1)
000462
               IF(@D5S1(KO).E0.0.0.AND.@D5S2(KO).E0.0.0) GO TO 274
000463
000464
               IF(@D5S1(KO).E@.O.O) GO TO 273
               DO 272 1=1,KO
000465
               WORK1(I)=D5(I)
000466
000467
               IK=I+(KO+1)
               WORK1(IK) = D5S1(I)
000468
000469
               00(1K)=00(1)
000470
           272 CONTINUE
000471
               WORK1(K0+1) = 0.0
               WORK1(L)=0.0
000472
000473
               00(K0+1)=0D5S1(K0)
               00(L)=00(K0+1)
000474
               CALL PLOT(LN, L, 00, WORK1, 0.5, 1.0, 0.0, 0.2E-01,
000475
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (0:1, *: F)
                         VS Q(KG/CM2)
              #28H F+31
000476
           273 CUNTINUE
               IF(RD5S2(KO).E0.0.0) GD TD 274
000477
```

```
DO 275 I=1,KO
000478
000479
               WORK2(1)=D5(1)
000480
               IK = I + (KO + 1)
000481
               WORK2(IK)=D5S2(I)
000482
               00(1K) = 00(1)
000483
          275 CONTINUE
000484
               WORK2(K0+1)=0.0
000485
               WORK2(L)=0.0
000486
               00(K0+1)=0D5S2(K0)
000487
               00(L) = 00(K0+1)
000488
               CALL PLOT(LN,L,00,WORK2,0.5,1.0,0.0,0.2E-01,
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (0:1, *:F)
                            VS @(KG/CM2)
              *28H F+32
          274 CONTINUE
000489
        CC
               PLOTS END
        CC
        CC
               PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
               L=2*(K0+1)
000490
000491
               LN=2
               IF(@D6S1(KO).E@.O.O.AND.@D6S2(KO).E@.O.O) GO TO 284
000492
               IF(QD6S1(KO).EQ.O.O) GO TO 283
000493
               DO 282 [=1,KO
000494
               WORK1(1)=D6(1)
000495
000496
               IK=I+(KO+1)
000497
               WORK1(IK) = D6S1(I)
               00(1K) = 00(1)
000498
000499
          282 CONTINUE
000500
               WORK1(K0+1)=0.0
000501
               WORK1(L)=0.0
000502
               00(K0+1)=0D6S1(K0)
000503
               00(L) = 00(K0+1)
000504
               CALL PLOT(LN,L,00,WORK1,0.5,1.0,0.0,0.2E+01,
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (0:1, *:F)
              *28H F+11
                        VS Q(KG/CM2)
000505
          283 CONTINUE
               IF(@D6S2(KO).E@.O.O) GO TO 284
000506
000507
               DO 285 I=1,KO
               WORK2(1) = D6(1)
000508
000509
               IK=I+(KO+1)
               WORK2(IK)=D6S2(I)
000510
000511
               00(1K) = 00(1)
          285 CONTINUE
000512
               WDRK2(K0+1)=0.0
000513
000514
               WORK2(L)=0.0
               QQ(KO+1)=QD6S2(KO)
000515
000516
              00(L)=00(K0+1)
               CALL PLOT(LN, L, 00, WORK 2, 0.5, 1.0, 0.0, 0.2E+01,
000517
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (D:1,*:F)
              #28H F+12
                           VS @(KG/CM2)
          284 CONTINUE
000518
        CC
              PLOTS END
        CC
              PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
        CC
000519
              L=2*(K0+1)
000520
              LN=2
```

```
000521
               IF(WD751(KO).E0.0.0.AND.0D752(KO).E0.0.0) GO TO 294
000522
               IF(@D7S1(KO).E0.0.0) GO TO 293
000523
               DO 292 I=1,KO
               WORK1(I)=D7(I)
000524
               IK = I + (KO + 1)
000525
               WORK1(IK) = D7S1(I)
000526
000527
               00(1K) = 00(1)
000528
           292 CONTINUE
000529
               WDRK1(K0+1)=0.0
000530
               WDRK1(L)=0.0
000531
               00(K0+1)=0D7S1(K0)
000532
               00(L) = 00(K0+1)
000533
               CALL PLOT(LN, L, 00, WORK1, 0.5, 1.0, 0.0, 0.15E+00,
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (0:1,*:F)
              *28H F+11
                         VS Q(KG/CM2)
000534
           293 CONTINUE
000535
               IF(@D7S2(KO).E@.O.O) GO TO 294
000536
               DO 295 I=1,KO
000537
               WORK2(1)=D7(1)
000538
               IK=I+(KO+1)
000539
               WURK2(IK)=D7S2(1)
000540
               00(1K) = 00(1)
000541
           295 CONTINUE
000542
               WURK2(K0+1)=0.0
               WDRK2(L)=0.0
000543
000544
               00(K0+1)=0D7S2(K0)
               00(L) = 00(K0+1)
000545
               CALL PLOT(LN,L,00,WORK2,0.5,1.0,0.0,0.15E+00,
000546
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (0:1, *:F) ,
              *28H F+12
                            VS Q(KG/CM2)
000547
           294 CONTINUE
        \mathsf{CC}
               PLOTS END
        CC
        CC
               PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
000548
               L=2*(K0+1)
000549
               LN=2
000550
               IF(0E5S1(KO).E0.0.0.AND.0E5S2(KO).E0.0.0) GO TO 774
000551
               IF(@E5S1(KO).E@.O.O) GO TO 773
000552
               DO 772 I=1.KO
000553
               WORK1(I)=E5(I)
               IK = I + (KO + 1)
000554
000555
               WORK1(IK) = E5S1(I)
000556
               00(1K) = 00(1)
000557
           772 CONTINUE
000558
               WORK1(K0+1)=0.0
               WORK1(L)=0.0
000559
000560
               00(K0+1)=0E5S1(K0)
000561
               00(L) = 00(K0+1)
000562
               CALL PLOT(LN,L,00,WORK1,0.5,1.0,0.0,1.00E-06,
              #92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (D:1, *:F)
              *28H F-31
                        VS Q(KG/CM2)
000563
          773 CONTINUE
000564
               IF(@E5S2(KO).E@.O.O) GD TD 774
000565
               DO 775 [=1,KO
000566
               WORK2(1)=E5(1)
```

```
000567
               IK=I+(KO+1)
               WORK2(IK)=E5S2(I)
000568
               00(1K) = 00(1)
000569
000570
           775 CONTINUE
               WDRK2(KO+1)=0.0
000571
000572
               WORK2(L)=0.0
000573
               00(K0+1)=0E5S2(K0)
000574
               00(L) = 00(KO+1)
               CALL PLOT(LN,L,00,WORK2,0.5,1.0,0.0,1.00E-06,
000575
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (D:1, *:F)
              #28H F-32
                            VS Q(KG/CM2)
000576
           774 CONTINUE
        CC
               PLOTS END
        CC
               PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
        CC
000577
               L=2*(K0+1)
000578
               LN=2
000579
               IF(0E6S1(KO).E0.0.0.AND.0E6S2(KO).E0.0.0) GD TD 784
               IF(@E6S1(KO).E@.O.O) GD TU 783
000580
000581
               DO 782 I=1,KO
000582
               WORK1(I)=E6(I)
000583
               IK = I + (KO + 1)
               WDRK1(IK) = E6S1(I)
000584
000585
               00(1K) = 00(1)
           782 CONTINUE
000586
000587
               WORK1(K0+1)=0.0
000588
               WORK1(L)=0.0
               QQ(KO+1) = QE6S1(KO)
000589
000590
               00(L) = 00(K0+1)
               CALL PLOT(LN,L,00,WORK1,0.5,1.0,0.0,0.4E-01,
000591
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (0:1,*:F)
              *28H F-11
                         VS @(KG/CM2)
          783 CONTINUE
000592
               1F(@E6S2(KO).E@.O.O) GD TD 784
000593
000594
               DD 785 I=1,KO
               WORK2(1)=E6(1)
000595
000596
               IK=1+(KO+1)
000597
               WORK2(IK)=E6S2(1)
000598
               00(1K) = 00(1)
000599
          785 CONTINUE
000600
               WORK2(KO+1)=0.0
000601
               WORK2(L)=0.0
000602
               QQ(KO+1)=QE6S2(KO)
000603
               00(L) = 00(K0+1)
               CALL PLOT(LN,L,00,WORK2,0.5,1.0,0.0,0.4E-01,
000604
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (D:1,*:F)
              #28H F-12
                           VS Q(KG/CM2)
000605
          784 CONTINUE
        \mathsf{CC}
               PLOTS END
        CC
               PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
        CC
000606
               L=2*(K0+1)
               LN=2
000607
000608
               IF(0E7S1(KO).E0.0.0.AND.0E7S2(KO).E0.0.0) GD TD 794
               IF(@E7S1(KO).E@.O.O) GO TO 793
000609
```

```
000610
               DO 792 1=1,KO
000611
               WORK1(1)=E7(1)
000612
               IK=I+(KO+1)
000613
               WORK1(IK) = E7S1(I)
000614
               00(1K) = 00(1)
           792 CONTINUE
000615
000616
               WORK1(KO+1)=0.0
000617
               WORK1(L)=0.0
               00(KO+1)=0E7S1(KO)
000618
000619
               00(L) = 00(K0+1)
000620
               CALL PLOT(LN,L,00,WORK1,0.5,1.0,0.0,1.00E-06,
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (D:1,*:F) ,
              *28H F-31
                         VS Q(KG/CM2)
           793 CONTINUE
000621
               IF(@E7S2(KO).E@.O.O) GD TD 794
000622
000623
               DO 795 I=1,KO
000624
               WORK2(I)=E7(I)
000625
               IK = I + (KO + 1)
000626
               WORK2(1K)=E7S2(1)
000627
               00(1K) = 00(1)
000628
           795 CONTINUE
000629
               WORK2(KO+1)=0.0
000630
               WORK2(L)=0.0
000631
               00(K0+1)=0E7S2(K0)
000632
               00(L)=00(K0+1)
               CALL PLOT(LN, L, 00, WURK 2, 0.5, 1.0, 0.0, 1.00 E-06,
000633
              *92H PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
              * DYNAMIC PRESSURE (0:1.*:F) .
              #28H F-32
                            VS Q(KG/CM2)
000634
           794 CONTINUE
        CC
               PLOTS END
000635
          4320
                  CONTINUE
000636
               STOP
000637
           100 FORMAT(1H0,10X, 'TABLE DF AR COEF. AND STABILITY PARAMETERS',//)
000638
           181 FORMAT(1H ,'NO.=',[2,2X,'0=',F7.4,2X,' 84=',E13.5,2X,' B3=',
              * E13.5,2X,' B2=',E13.5,2X,' B1=',E13.5,2X,' B0=',E13.5,/)
           182 FURMAT(1H ,'NO.=',12,2X,'0=',F7.4,2X,' G+1=',E13.5,2X,' G-1=',
000639
              * E13.5,2X,' F+3=',E13.5,2X,' F+1=',E13.5,2X,' F+2=',E13.5,/)
           682 FORMAT(1H ,'NO.=',12,2X,'0=',F7.4,2X,' G+1=',E13.5,2X,' G-1=',

* E13.5,2X,' F-3=',E13.5,2X,' F-1=',E13.5,2X,' F-3=',E13.5,//)
000640
        C 183 FORMAT(1H ,'NO.=', 12, 2X, 'Q=', F7.4, 2X, 'G+11=', E13.5, 2X, 'SD11=',
              * E13.5,2X,'G+12=',E13.5,2X,'SD12=',E13.5,/)
          184 FORMAT(1H ,'NO.=', 12, 2X, 'Q=', F7.4, 2X, 'G-11=', E13.5, 2X, 'SD11=',
              * E13.5,2X,'G-12=',E13.5,2X,'SD12=',E13.5,/)
        C 185 FORMAT(1H ,'NO.=', [2,2X,'0=',F7.4,2X,'F+31=',E13.5,2X,'SD31=',
              * E13.5,2X,'F+32=',E13.5,2X,'SD32=',E13.5,/)
          186 FORMAT(1H ,'NO.=', 12,2X,'0=',F7.4,2X,'F+11=',E13.5,2X,'SD11=',
              * E13.5,2X,'F+12=',E13.5,2X,'SD12=',E13.5,/)
          187 FORMAT(1H ,'NO.=', [2,2X,'0=',F7.4,2X,'F+11=',E13.5,2X,'SD11=',
              * E13.5,2X,'F+12=',E13.5,2X,'SD12=',E13.5,/)
          188 FORMAT(1H ,'NO.=', 12, 2X, '0=', F7.4, 2X, 'F-31=', E13.5, 2X, 'SD31=',
              * E13.5,2X,'F-32=',E13.5,2X,'SD32=',E13.5,/)
        C 189 FORMAT(1H ,'NO.=',12,2X,'0=',F7.4,2X,'F-11=',E13.5,2X,'SD11=',
             * E13.5,2X,'F-12=',E13.5,2X,'SD12=',E13.5,/)
        C 190 FORMAT(1H ,'NO.=', |2,2X,'0=',F7.4,2X,'F-31=',E13.5,2X,'SD31=',
             * E13.5,2X,'F-32=',E13.5,2X,'SD32=',E13.5,/)
000641
         122 FURMAT(1H ,'#### G(+1) #####')
000642
         132
              FORMAT(1H , ' *** * G(-1) * * * * * * ')
000643
              FORMAT(1H , ' #### F+3 #####')
         142
000644
         152
              FORMAT(1H , ' # # # # F+1 # # # # # ')
000645
              FORMAT(1H , 1 & # # # F+2
         162
000646
         442
              000647
              FORMAT(1H ,'**** F-1 *****')
         452
000648
         462
             FORMAT(1H , ' * * * * F = 3 * * * * * ')
000649
          500 FORMAT(F10.0)
000650
          510 FORMAT (4D20.10)
          556 FURMAT(215)
000651
          688 FORMAT(1H , FITTING OF STRAIGHT LINE AND PARABOLIC CURVE TO STABIL
000652
             *ITY PARAMETERS',//)
000653
              FND
```

```
000654
               SUBROUTINE FLSE(KSU, KSU1, JISU, I JIS, Q, FLMA, FLMAS, X, XX, XX, B, SD)
        C
               LEAST SQUARES ESTIMATES
        C
               INPUT:
        C
                KSU :KSU=KAISU
         C
                KSU1:KSU1=KAISU1=KAISU+1
        C
                JISU:JISU=1,OR 2
        C
                IJIS:IJIS=2(JISU=1),OR 3(JISU=2)
        C
                @(KSU1):DYNAMIC PRESSURE
        C
               OUT PUT:
        C
               A1#0+A0
        C
               A2#Q##2+A1#Q+A0
000655
               DIMENSION X(KSU,
                                   3),XX(
                                             3,
                                                   3),XXX(
                                                             3,KSU),B(
                                                                          3)
               DIMENSION O(KSU1), FLMA(KSU1), FLMAS(KSU1)
000656
               DD 10 1=1,KSU
000657
000658
               X([,1)=0(])**2
000659
               X(I)
                      2) = 0(1)
000660
               X(1,3)=1.0
            10 CONTINUE
000661
000662
               DO 30 1=1,3
               DO 30 J=1.3
000663
000664
               W=0.0
000665
               DO 20 K=1.KSU
000666
               W=W+X(K,I)*X(K,J)
            20 CONTINUE
000667
000668
               W = (U \setminus I) \times X
000669
            30 CONTINUE
000670
               IF(JISU.E0.1) GO TO 2
               THIS PROGRAM USES A STANDARD SUBROUTINE MINVS(XX,IJIS,IJIS,1.0E-5,
        C
               ILL) TO OBTAIN INVERSE MATRIX XX(IJIS, IJIS) OF ORIGINAL MATRIX
               (SILI'SILI)XX
000671
               CALL MINVS(XX,IJIS,IJIS,1.0E-5,ILL)
000672
               IF(ILL.E0.0) GO TO 1
000673
               WRITE(6,130)
000674
           130 FORMAT(1H ,'INVERS OF XX NOT OBTAINED : (ILL IS NOT EQUAL TO ZERO)
              *1,/)
000675
               STOP
000676
             2 DETR=1.0/(XX(2,2)*XX(3,3)-XX(2,3)*XX(3,2))
000677
               P1=XX(3,3)*DETR
               P2=-XX(2,3)*DETR
000678
000679
               P3=-XX(3,2) *DETR
000680
               P4=XX(2,2) #DETR
000681
               XX(2,2)=P1
               XX(2,3)≖P2
000682
000683
               XX(3,2)=P3
               XX(3,3)=P4
000684
000685
               XX(1,1)=0.0
               XX(1,2)=0.0
000686
000687
               XX(1,3)=0.0
               XX(2,1)=0.0
000688
000689
               XX(3,1)=0.0
000690
             1 CONTINUE
000691
               DO 50 1=1.3
               DO 50 J=1,KSU
000692
000693
               W=0.0
               00 40 K=1.3
000694
               W=W+XX([,K)*X(J,K)
000695
           40 CONTINUE
000696
```

```
000697
               W = (U, I) \times XX
            50 CONTINUE
200698
000699
               DO 70 1=1.3
               W = 0.0
 20700
30701
               DO 60 J=1,KSU
000702
               W=W+XXX(I,J) #FLMA(J)
            60 CONTINUE
000703
000704
               B([)=W
000705
           70 CONTINUE
200706
               IF(JISU.EQ.1) GO TO 4
               IF(JISU.EQ.2) GO TO 5
000707
000708
             3 CONTINUE
               DO 90 I=1.KSU
000709
000710
               W = 0.0
               DO 80 J=1.3
000711
000712
               W=W+X(1,J)*B(J)
            80 CONTINUE
000713
000714
               FLMAS(1)=W
000715
            90 CONTINUE
000716
               W=0.0
               W1=0.0
000717
000718
               DO 100 I=1,KSU
000719
               W=W+(FLMAS(I)~FLMA(I))*#2
000720
          100 CONTINUE
                  WRITE(6,523) W
000721
               W1=(FLMA(1)**2)*FLOAT(KSU)
000722
               SD=SGRT(W/W1) #100.0
000723
               GO TO 9
             4 CONTINUE
000724
               O(KSU1) = -8(3)/8(2)
000725
000726
               B(1)=0.0
               GD TD 3
000727
             5 CONTINUE
000728
000729
               0(KSU1)=0.0
000730
               IF(B(1).GT.0.0) GD TD 6
000731
               GO TO 7
             6 F=(B(1)*(-B(2)/(2.0*B(1)))**2)+B(2)*(-B(2)/(2.0*B(1)))+B(3)
000732
000733
               IF(F.GT.0.0) GO TO 8
             7 P1=B(2)**2-4.0*B(1)*B(3)
000734
000735
               IF(P1.LE.O.O) GO TO 8
000736
               P1=SQRT(P1)
000737
               Q1=(-B(2)-P1)/(2.0*B(1))
000738
               02=(-B(2)+P1)/(2.0*B(1))
000739
               @(KSU1)=01
        \mathsf{CC}
               WRITE(6,110) 01,02
000740
               GO TO 3
000741
             9 CONTINUE
               PRINT OUT
               WRITE(6,525) JISU,SD,(B(1), I=1,
        CC
                                                   3)
000742
               FLMA(KSU1)=0.0
000743
               FLMAS(KSU1)=0.0
000744
               WRITE(6,527)
000745
               DO 530 I=1.KSU
000746
               WRITE(6,540) I,Q(1),FLMA(1)
000747
           530 CONTINUE
000748
               WRITE(6,545) @(KSU1)
000749
               IF(IJIS.E0.2) WRITE(6,524) (B(1),1=2,3)
000750
               IF(IJIS.E0.3) WRITE(6,525) (B(1),1=1,3)
```

```
000751
              RETURN
000752
            8 CONTINUE
000753
              WRITE(6,120)
000754
              RETURN
        C 110 FURMAT(1H ,'01(KG/CM2)=',E13.5,2X,'02(KG/CM2)=',E13.5,/)
          120 FURMAT(1H , FITTING TO THIS PARAMETER DOES NOT PREDICT THE INSTABI
000755
             *L1TY',/)
        C 523
                FORMAT(1H ,'(FS-F)**2=',E13.5,/)
000756
          524 FURMAT(1H , COEFFICIENTS A1 AND AO OF THE FITTED STRAIGHT LINE, 1, 2
             #(2X,E15.7),/)
          525 FORMAT(1H , COEFFICIENTS A2, A1 AND A0 OF THE FITTED PARABOLIC CUR
000757
             *VE,',3(2X,E15.7),/)
        C 525 FORMAT(1H ,11,2X,'ORDER',2X,'STANDARD DEVIATION=',E13.5,/(1H ,'COE
            AFFICIENTS B2,B1,B0=', 3(E13.5,2X)))
          527 FORMAT(1H0,3X,'I',5X,'Q(KG/CM2)',10X,'VALUES OF PARAMETER',/)
000758
000759
          540 FORMAT(1H ,2X,12,2(2X,E15.7))
          545 FORMAT(1H ,70X, 'PREDICTED @ FOR INSTABILITY = ',E15.7,/)
000760
000761
              END
```

```
000762
               SUBROUTINE PLOT(LN,N,X,Y,XMIN,XMAX,YMIN,YMAX,TITL,AXIS)
000763
               CHARACTER
                          BLANK, ASTER, PLUS, XY, XY2
               DIMENSION X(200), Y(200), TITL(23), XY(51,101), XA(11), AXIS(7)
000764
000765
               DIMENSIUN XY2(51,101)
000766
               DATA BLANK, ASTER, PLUS/1H , 1H*, 1H0 /
000767
               XL=XMIN
000768
               XU=XMAX
000769
               YL=YMIN
               YU=YMAX
000770
000771
               IF(XL.LT.XU) GO TO 15
000772
               XL = X(1)
000773
               XU=X(1)
               DO 10 1=2.N
000774
000775
               IF(X(1),LT,XL) XL=X(1)
               IF(X(1),GT,XU) XU=X(1)
000776
000777
           10 CONTINUE
           15 IF(YL.LT.YU) GO TO 25
000778
000779
               YL=Y(1)
000780
               YU=Y(1)
000781
               DO 20 1=2.N
000782
               IF(Y(1).LT.YL) YL=Y(1)
               IF(Y(1).GT.YU) YU=Y(1)
000783
           20 CONTINUE
000784
000785
           25 DX=(XU-XL)/100.0
               DY=(YU-YL)/50.0
000786
               00 30 1=1.51
000787
               DO 30 J=1,101
000788
000789
               XY2(1,J)=BLANK
000790
           30 XY(1,J)=BLANK
000791
               DO 50 1=1.N
000792
               AX=(X(1)-XL)/DX
000793
               IF(AX.LE.-0.5.OR.AX.GE.100.5) GO TO 50
               LX=AX+1.5
000794
000795
               AY = (Y(1) - YL)/DY
000796
               IF(AY.LE.-0.5.OR.AY.GE.50.5) GO TO 50
000797
               LY=51-IFIX(AY+0.5)
000798
               IF(LN.E0.1) XY(LY,LX)=PLUS
000799
               IF(LN.E0.1) GO TO 50
000800
               IF(1.LE.N/2) XY(LY,LX)=PLUS
000801
               IF(1.GT.N/2) XY2(LY,LX)=ASTER
           50 CONTINUE
000802
000803
               WRITE(6,62) TITL
           62 FORMAT(1H1/1H ,15X,23A4/ )
000804
000805
               DO 80 1=1,51
000806
               IF(MOD(1,5).NE.1) GO TO 72
               YA=YL+DY*FLOAT(51-1)
000807
000808
               WRITE(6,70) YA
000809
           70 FORMAT(1H ,1PE9.2,1X,10(10H+-----),1H+)
000810
               GO TO 76
000811
           72 WRITE(6,74)
000812
           74 FORMAT(1H ,10X,10(10HI
                                               ),1HI)
           76 WRITE(6,78)(XY(I,J),J=1,101)
000813
000814
               WRITE(6,78)(XY2(1,J),J=1,101)
           78 FORMAT(1H+,10X,101A1)
000815
000816
           80 CONTINUE
               DO 90 1=1.11
000817
           90 XA(1)=XL+DX*FLOAT((1-1)*10)
000818
000819
               WRITE(6,95) XA
000820
           95 FORMAT(1H ,6X,11(1PE9.2,1X))
000821
               WRITE(6,92) AXIS
000822
           92 FORMAT(1H0,1H ,50X,7A4/ )
000823
              RETURN
000824
               END
```

```
SUBROUTINE SAUT(M,M1,M0,A,PD,PMD,BM,X,Y,H1)
000825
               THIS SUBROUTINE PROGRAM IS USED FOR CALCULATION OF JURY'S
        C
               STABILITY PARAMETERS.
        C
        C
               INPUTS REQUIRED :
                  M : URDER OF THE CHARACTERISTIC EQUATION.
        C
        C
                  M : EVEN ONLY
        C
C
                  M1 : M+1
                  MO : M-1
        C
C
                  A(M1): COEFFICIENTS OF THE CHARACTERISTIC EQUATION.
               OUTPUTS:
                  PD(M) : STABILITY DETERMINANTS.
               REAL *8 PMD(M), BM(MO, MO), S
000826
000827
               DIMENSION PD(M), A(M1)
               DIMENSION X(MO,MO),Y(MO,MO),HI(MO,MO)
000828
               INITIAL CLEARING : START
        \mathsf{CC}
000829
               MD2=M/2
000830
               IH2=0
000831
               111=0
               DO 100 I=1,MO
000832
               DO 100 J=1,MO
000833
               0.0 = (U,1)X
000834
               Y(I,J)=0.0
000835
          100 CONTINUE
000836
        CC
               INITIAL CLEARING : END
               X(KK,I) COMPUTATION : START
        CC
               DO 1100 KK=1,M0
000837
000838
               DO 110 I=KK,MO
000839
               II=M1+KK-I
000840
               X(KK \cdot I) = A(II)
000841
          110 CONTINUE
000842
         1100 CONTINUE
        cc
               X(KK,1) COMPUTATION : END
        CC
               Y(KK, I) COMPUTATION : START
               IM2=M0
000843
000844
               DO 2100 KK=1,MO
000845
               DO 210 [=1, [M2
000846
               II=M1-KK-I
000847
               Y(KK,I)=A(II)
000848
          210 CONTINUE
000849
               IM2=IM2-1
         2100 CONTINUE
000850
               Y(KK, I) COMPUTATION : END
        \mathsf{CC}
               HI(I,J)=X(I,J)+Y(I,J)*P COMPUTATION : START
          300 CONTINUE
000851
               IM1=MD2
000852
000853
               P=1.0
               IF(IH2.EQ.1) P=-1.0
000854
000855
               DO 3000 KK=1,MD2
000856
               IM2=M0
000857
               DO 320 I=1,MO
               DO 320 J=1,MO
000858
000859
               9*(L,I)Y+(L,I)X=(L,I)IH
               BM(1,J)=0.0
000860
000861
          320 CONTINUE
               IM2=IM2-(MD2-IM1)#2
000862
000863
               DO 330 I=1, IM2
               DO 330 J=1, IM2
000864
000865
               II=MD2-IM1+I
```

```
000866
               JJ=MD2-IM1+J
000867
              BM(1,J)=H1(11,JJ)
000868
          330 CONTINUE
000869
              S=0.0
000870
              IF(IM2.EQ.2) GO TO 332
000871
              1F(1M2.E0.1) GD TD 331
000872
               ILL=0
              THIS PROGRAM USES A STANDARD SUBROUTINE MDETD(BM, MO, 1M2, 1.0D-14, S,
        C
              ILL) TO GIVE THE VALUE S. OF THE DETERMINANT BM(1M2,1M2).
        C
              CALL MDETD(BM,MO,1M2,1.0D-14,S,1LL)
000873
000874
              GO TO 333
000875
          331 CONTINUE
              S=BM(1,1)
000876
000877
              GO TO 333
          332 CONTINUE
000878
000879
              S=(BM(1,1)*BM(2,2)-BM(1,2)*BM(2,1))
              GO TO 333
000880
000881
          333 CONTINUE
               111=111+1
000882
000883
              PMD(III)=S
000884
              IF(ILL.NE.0) PMD(III)=9999.9
000885
              IM1=[M1-1
         3000 CONTINUE
000886
              IF(IH2.E0.1) GO TO 340
000887
000888
              !H2=!H2+1
000889
              GD TO 300
000890
          340 CONTINUE
        CC
              HI(I,J)=X(I,J)+Y(I,J)*P COMPUTATION : END
              THE INPUTS TO THE MAIN PROGRAM : START
000891
              DO 400 1=1.M
              PD(1)=SNGL(PMD(1))
000892
000893
          400 CONTINUE
              THE INPUTS TO THE MAIN PROGRAM : END
000894
              RETURN
000895
              END
```

Output for program JURY-CE4-EB

TABLE OF AR COEF. AND STABILITY PARAMETERS

ND.= 1	0= 0.6970	84=	0.100000+01	83= -0.38706D+01	B2=	0.572000+01	81= -0.38226D+01	80≈	0.975220+00
NO.= 1	0= 0.6970	G+1=	0.19198E-02	G-1= 0.15388E+02	F+3=	0.79716E-02	F+1= 0.19752E+01	F+2=	0.97539E-01
NO.= 1	0= 0.6970	G+1=	0.19198E-02	G-1= 0.15388E+02	F-3=	0.41491E-06	F-1= 0.24777E-01	F+3=	0.42651E-06
NO.= 2	Q= 0.7240	B4=	0.100000+01	B3= ~0.387080+01	82=	0.571550+01	B1= -0.38134D+01	80=	0.970450+00
NO.= 2	0= 0.7240	G+1=	0.17543E-02	G-1= 0.15370E+02	-	0.91374E-02	F+1= 0.19705E+01		0.11642E+00
NO.= 2	0= 0.7240	G+1=	0.17543E-02	G-1= 0.15370E+02		0.53357E-06	F-1= 0.29546E-01	_	0.54967E-06
NO.= 3	e= 0.7720	84=	0.100000+01	83= -0.387640+01	B2=	0.573060+01	81= -0.382720+01	B0=	0.974700+00
NO.= 3	0= 0.7720	G+1=	0.171798-02	G-1= 0.15409E+02	F+3=	0.85031E-02	F+1= 0.19747E+01	F+2=	0.99789E-01
NO.= 3	0= 0.7720	G+1=	0.17179E-02	G-1= 0.15409E+02	F-3=	0.40902E-06	F-1= 0.25296E-01	F-3=	0.42440E-06
NO.= 4	9= 0.8020	84=	0.100000+01	83= -0.386920+01	B2=	0.571140+01	B1= -0.38098D+01	80=	0.96946D+00
ND.= 4	9= 0.8 020	G+1=	0.193478-02	G-1= 0.15360E+02	F+3=	0.10795E-01	F+1= 0.19695E+01	F+2=	0.12047E+00
ND.= 4	0= 0.8020	G+1=	0.19347E-02	G-1= 0.15360E+02	F-3=	0.49821E-06	F-1= 0.30536E-01	F-3=	0.52175E-06
NO.= 5	Q= 0.8230	84=	0.100000+01	B3= -0.38778D+01	B2=	0.573420+01	81= -0.38297D+01	80=	0.975190+00
NO.= 5	0= 0.8230	G+1=	0.18804E-02	G-1= 0.15417E+02	F+3=	0.75496E-02	F+1= 0.19752E+01	F+2=	0.97809E-01
ND.= 5	0= 0.8230	G+1=	0.18804E-02	G-1= 0.15417E+02	F-3=	0.226228-06	F-1= 0.24814E-01	F-3=	0.24329E-06
NO.= 6	0= 0.8360	84 =	0.100000+01	83= -0.387320+01	B2=	0.572210+01	81= -0.381890+01	80=	0.972030+00
NO.= 6	9= 0.8360	G+1=	0.20235E-02	G-1= 0.15386E+02	F+3=	0.90543E-02	F+1= 0.19720E+01	F+2=	0.11028E+00
NO.= 6	9= 0.8360	G+1=	0.20235E-02	G-1= 0.15386E+02	F-3=	0.27297E-06	F-1= 0.27970E-01	F-3=	0.27846E-06
NO.= 7	e= 0.8470	84=	0.100000+01	83= -0.388670+01	B2=	0.575810+01	B1= -0.38514D+01	B0=	0.981850+00
NO.= 7	0= 0.8470	G+1=	0.18743E-02	G-1= 0.15478E+02	F+3=	0.522328-02	F+1= 0.19818E+01	F+2=	0.71550E-01
NO.= 7	e= 0.8470	G+1=	0.18743E-02	G-1= 0.15478E+02	F-3=	0.79667E-07	F-1= 0.18153E-01	F-3=	0.89669E-07

FITTING OF STRAIGHT LINE AND PARABULIC CURVE TO STABILITY PARAMETERS

**** G(+1) ****

i	e(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.1919804E-G2
2	0.7240000E+00	0.1754311E-02
3	0.77200008+00	0.1717871E-02
4	0.8020000E+00	0.1934658E-02
5	0.8230000E+00	0.1880396E-02
6	0.8360000E+00	0.20234626-02
7	0.8470000E+00	0.1874301E-02

```
PREDICTED @ FOR INSTABILITY = -0.1819606F+01
COEFFICIENTS AT AND AO OF THE FITTED STRAIGHT LINE.
                                                          0.7185265E-03
                                                                             0.1307435F-02
FITTING TO THIS PARAMETER DOES NOT PREDICT THE INSTABILITY
**** G(-1) ****
         Q(KG/CM2)
                              VALUES OF PARAMETER
   I
        0.6970000E+00
                           0.1538844E+02
        0.7240000E+00
0.7720000E+00
                           0.1537011E+02
0.1540886E+02
        0.8020000E+00
                           0.1535976E+02
0.1541686E+02
        0.8230000E+00
        0.8360000E+00
                           0.1538619E+02
                           0.1547806E+02
        0.8470000E+00
                                                                            PREDICTED @ FOR INSTABILITY = -0.4361302E+02
COEFFICIENTS AT AND AO OF THE FITTED STRAIGHT LINE. 0.3468781E+00
                                                                             0.1512840F+02
FITTING TO THIS PARAMETER DOES NOT PREDICT THE INSTABILITY
**** F+3 ****
   1 . 0(KG/CM2)
                              VALUES OF PARAMETER
        0.6970000E+00
                           0.7971630E-02
                           0.9137370E-02
        0.7240000E+00
         0.7720000E+00
                           0.8503117E-02
        0.8020000E+00
                           0.1079517E-01
        0.8230000E+00
0.8360000E+00
                           0.7549625E-02
0.9054273E-02
        0.8470000E+00
                           0.5223237E-02
                                                                            PREDICTED @ FOR INSTABILITY = 0.1795109E+01
COEFFICIENTS A1 AND AO OF THE FITTED STRAIGHT LINE. -0.8242857E-02 0.1479683E-01
                              VALUES OF PARAMETER
   ı
         0(KG/CM2)
        0.6970000E+00
                           0.7971630E-02
        0.7240000E+00
0.7720000E+00
                           0.9137370E-02
0.8503117E-02
                           0.1079517E-01
0.7549625E-02
0.9054273E-02
0.5223237E-02
        0.8020000E+00
        0.8230000E+00
        0.8360000E+00
        0.8470000E+00
                                                                            PREDICTED & FOR INSTABILITY = 0.9069713E+00
COEFFICIENTS A2, A1 AND A0 OF THE FITTED PARABOLIC CURVE, -0.4507822E+00
                                                                                     0.6874999E+00 -0.2527307E+00
**** F+1 ****
   ı
         O(KG/CM2)
                             VALUES OF PARAMETER
   1
        0.6970000E+00
                           0.1975223E+01
                           0.1970453E+01
        0.7240000E+00
        0.7720000E+00
                           0.1974704E+01
0.1969463E+01
        0.8020000E+00
                           0.1975185E+01
0.1972029E+01
         0.8230000E+00
        0.8360000E+00
        0.847C000E+00
                           0.19818478+01
                                                                            PREDICTED @ FOR INSTABILITY = -0.8410272E+02
```

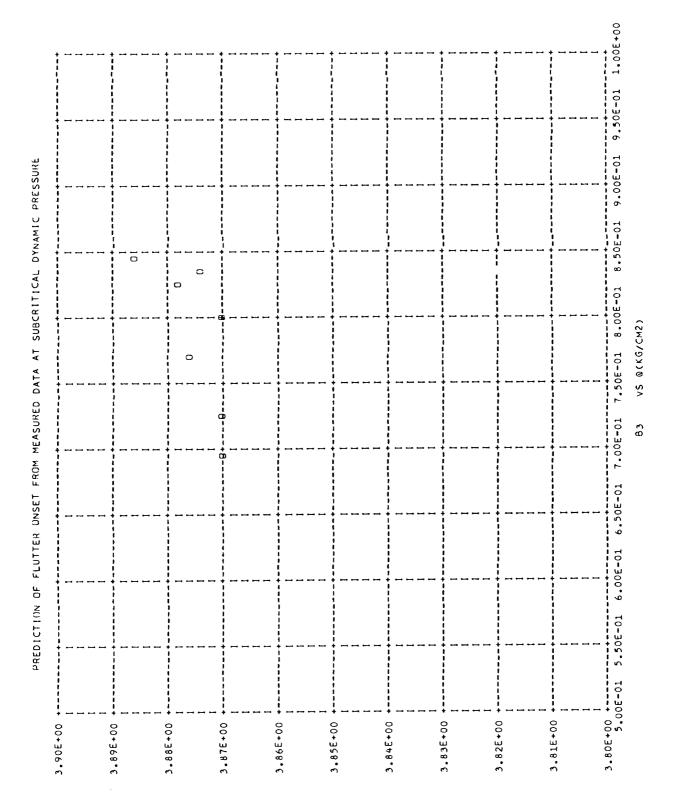
COEFFICIENTS AT AND AD OF THE FITTED STRAIGHT LINE, 0.2325535E-01 0.1955838E+01

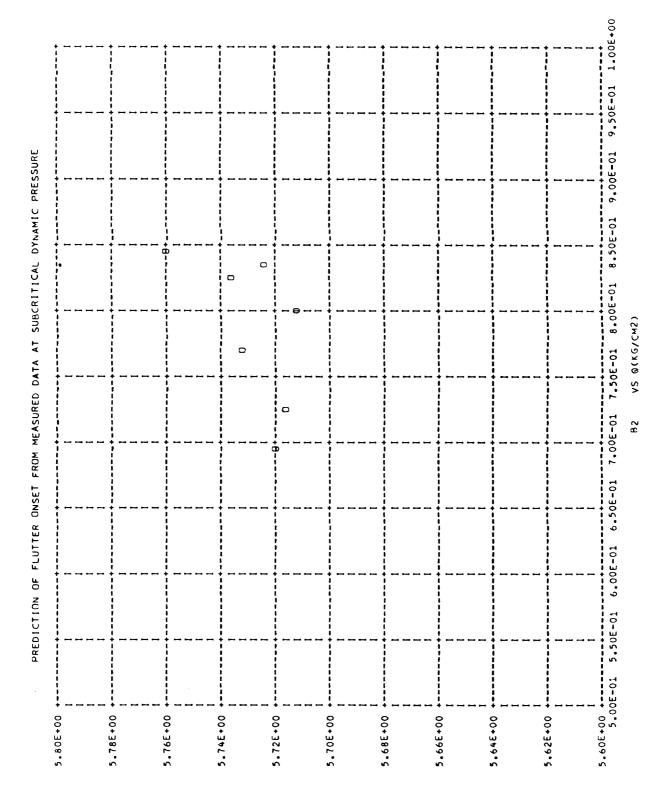
FITTING TO THIS PARAMETER DOES NOT PREDICT THE INSTABILITY

```
**** F+2 ****
                                VALUES OF PARAMETER
          0(KG/CM2)
   ı
         0.6970000E+00
                             0.9753942E-01
         0.7240000E+00
0.7720000E+00
0.8020000E+00
                             0.1164151E+00
0.9978908E-01
0.1204739E+00
         0.8230000E+00
                             0.9780931E-01
                             0.7154977E-01
         0.8470000E+00
                                                                                   PREDICTED # FOR INSTABILITY # 0.1928276E+01
CDEFFICIENTS AT AND AD OF THE FITTED STRAIGHT LINE, -0.8926499E-01
                                                                                     0.1721275E+00
   i
          0(KG/CM2)
                                VALUES OF PARAMETER
                             0.9753942E-01
0.1164151E+00
0.9978908E-01
0.1204739E+00
         0.6970000E+00
         0.7240000E+00
         0.7720000E+00
         0.8020000E+00
0.8230000E+00
                              0.9780931E-01
                             0.1102798E+00
         0.8360000E+00
         0.8470000E+00
                             0.7154977E-01
                                                                                   PREDICTED & FOR INSTABILITY = 0.9283137E+00
COEFFICIENTS A2, A1 AND AO OF THE FITTED PARABOLIC CURVE, -0.3886291E+01
                                                                                           0.5906579E+01 -0.2134084E+01
***** F-3 *****
                                VALUES OF PARAMETER
   ı
          0(KG/CH2)
                             0.4149108E-06
0.5335715E-06
0.4090179E-06
0.4982120E-06
         0.6970000E+00
         0.7240000E+00
0.7720000E+00
         0.8020000E+00
                             0.2262224E-06
0.2729712E-06
         0.8230000E+00
         0.8360000E+00
         0.8470000E+00
                             0.7966730E-07
                                                                                   PREDICTED & FOR INSTABILITY = 0.9558252E+00
CDEFFICIENTS AT AND AO OF THE FITTED STRAIGHT LINE, -0.2046195E-05 0.1955805E-05
          e(KG/CM2)
                                 VALUES OF PARAMETER
   ı
                             0.4149108E-06
0.5335715E-06
0.4090179E-06
0.4982120E-06
0.2262224E-06
0.2729712E-06
         0.6970000E+00
         0.7240000E+00
0.7720000E+00
         0.8020000E+00
         0.8230000E+00
         0.8360000E+00
         0.8470000E+00
                             0.7966730E-07
                                                                                   PREDICTED & FOR INSTABILITY = 0.8604007E+00
                                                                                            0.5496826E-04 -0.1996021E-04
COEFFICIENTS A2, A1 AND AO OF THE FITTED PARABOLIC CURVE, -0.3692410E-04
00000 F-1 00000
                                VALUES OF PARAMETER
         O(KG/CH2)
   1
         0.6970000E+00 0.2477694E-01
   ì
```

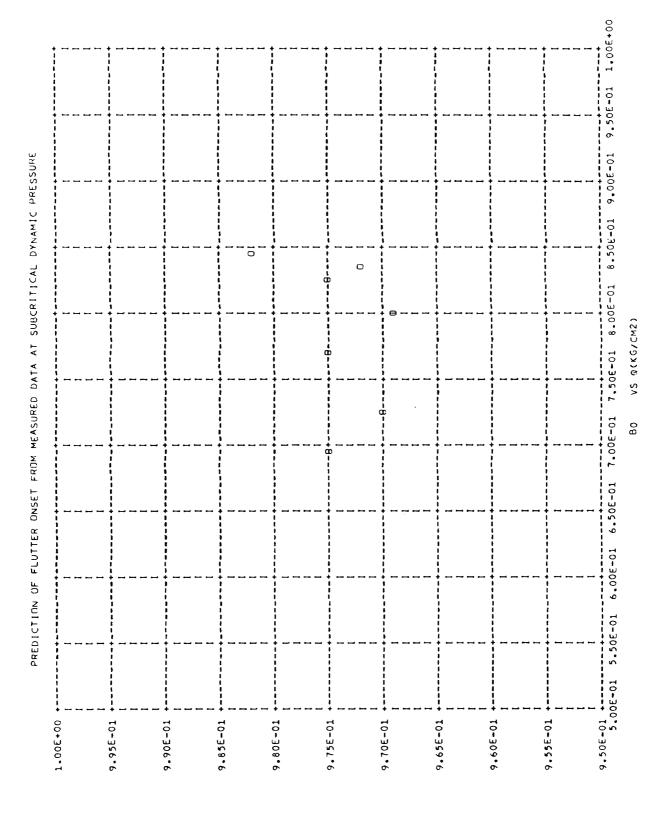
36

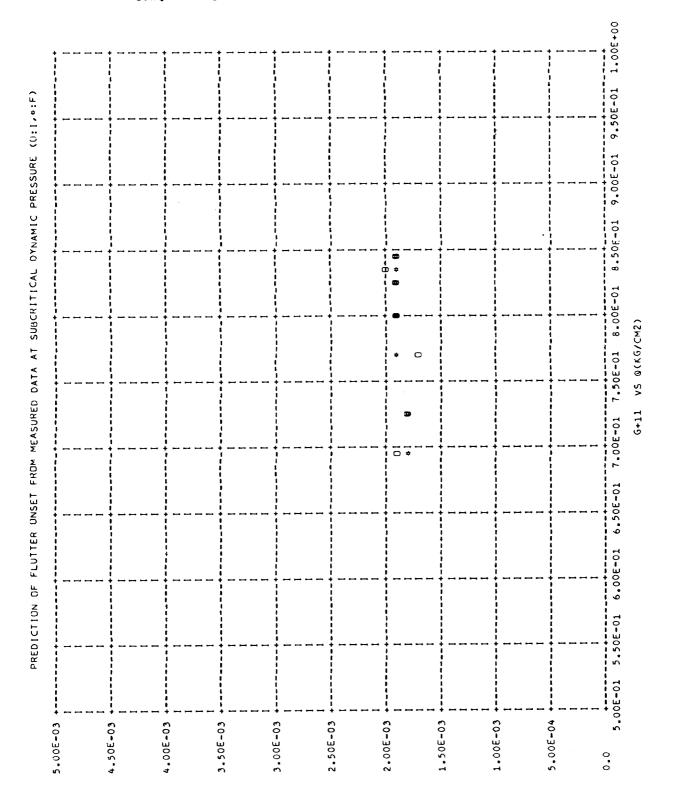
```
0.7240000E+00
   2
                            0.29546328-01
         0.7720000E+00
                            0.2529585E-01
0.3053647E-01
         0.8020000E+00
         0.8230000E+00
                            0.2481437E-01
                            0.2797049E-01
         0.8360000E+00
         0.8470000E+00
                            0.1815277E-01
                                                                               PREDICTED @ FOR INSTABILITY = 0.1918117E+01
COEFFICIENTS AT AND AO OF THE FITTED STRAIGHT LINE, -0.2284816E-01
                                                                                 0.4382544E-01
   I
         @(KG/CM2)
                               VALUES OF PARAMETER
        0.6970000E+00
                            0.2477694E-01
                            0.2954632E-01
0.2529585E-01
0.3053647E-01
         0.7240000E+00
0.7720000E+00
                            0.2481437E-01
0.2797049E-01
         0.8230000E+00
         0.8360000E+00
         0.8470000E+00
                            0.1815277E-01
                                                                               PREDICTED @ FOR INSTABILITY = 0.9286213E+00
COEFFICIENTS A2, A1 AND A0 OF THE FITTED PARABOLIC CURVE, -0.9798660E+00
                                                                                      0-1488897E+01 -0-5376464E+00
00000 F-3 ****
   I
          @(KG/CM2)
                              VALUES OF PARAMETER
                           0.4265086E-06
0.5496722E-06
0.4243958E-06
0.5217505E-06
         0.6970000E+00
        0.7240000E+00
0.7720000E+00
         0.8020000E+00
         0.8230000E+00
                            0.2432935E-06
         0.8360000E+00
         0.8470000E+00
                            0.8966919E-07
                                                                              PREDICTED & FOR INSTABILITY = 0.9612810E+00
COEFFICIENTS AT AND AO OF THE FITTED STRAIGHT LINE. -0.2063305E-05 0.1983416E-05
   1
          0(KG/CM2)
                               VALUES OF PARAMETER
                            0.4265086E-06
0.5496722E-06
         0.6970000F+00
         0.7240000E+00
                            0.4243958E-06
0.5217505E-06
0.2432935E-06
         0.7720000E+00
         0.8020000E+00
         0.8230000E+00
0.8360000E+00
                            0.2784562E-06
         0.8470000E+00
                            0.8966919E-07
                                                                               PREDICTED @ FOR INSTABILITY = 0.8608606E+00
COEFFICIENTS A2, A1 AND A0 OF THE FITTED PARABOLIC CURVE, -0.3860769E-04
                                                                                     0.5755090E-04 -0.2093188E-04
```

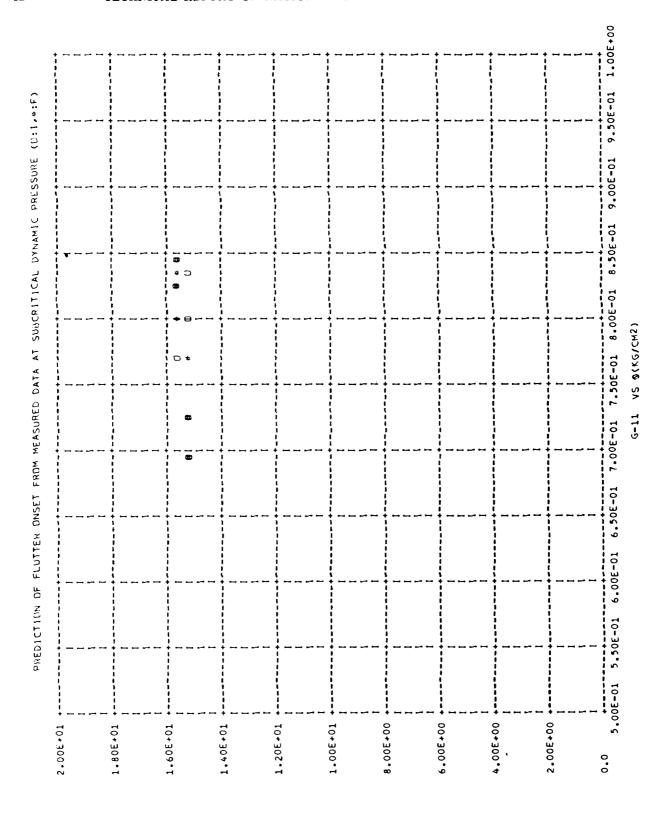


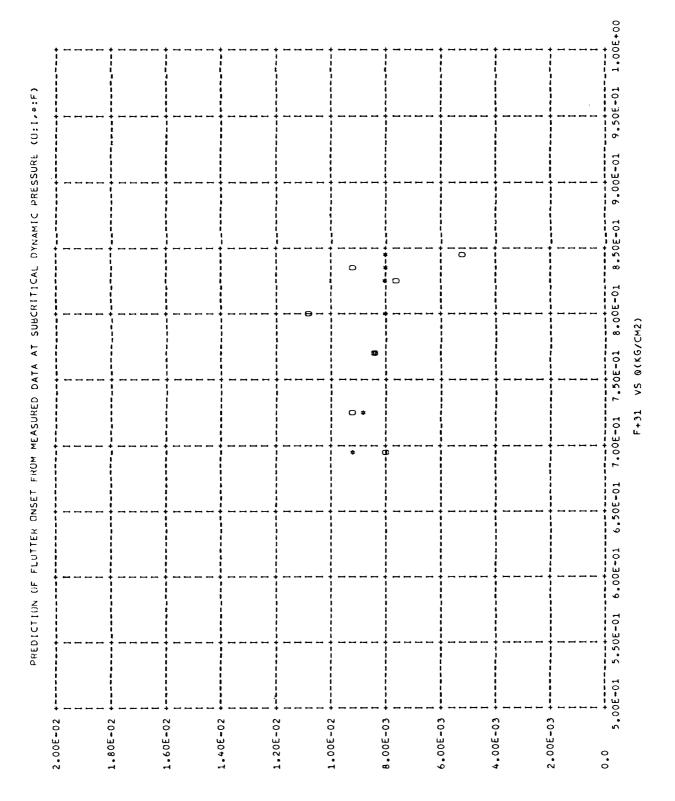


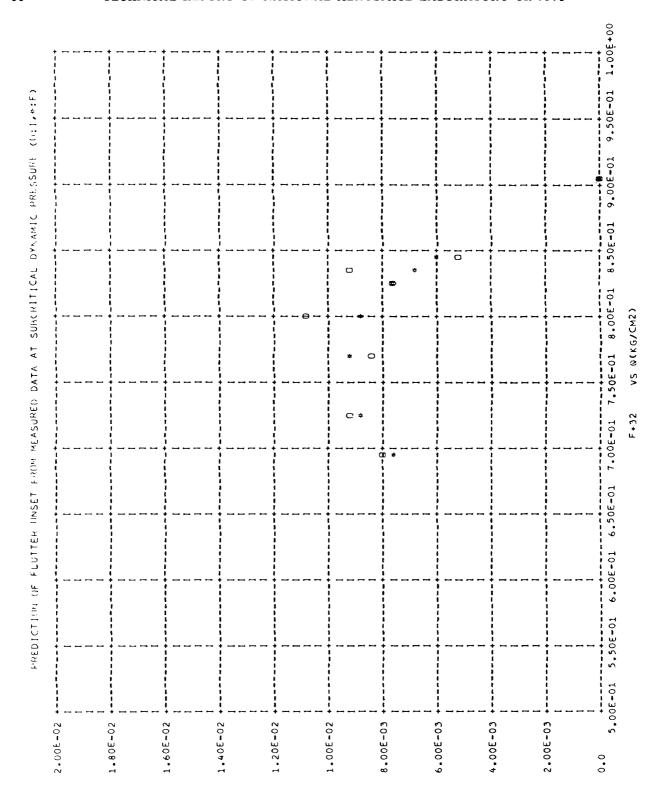
PREDICTION OF FLUTTER UNSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE 0 VS O(KG/CM2) 0 0 **B**1 0 3.83E+00 3.82E+00 3.81E+00 3.81E+00 3.82E+00 3.84E+00 3.84E+00 3.86E+00 3.85E+00 3.85E+00



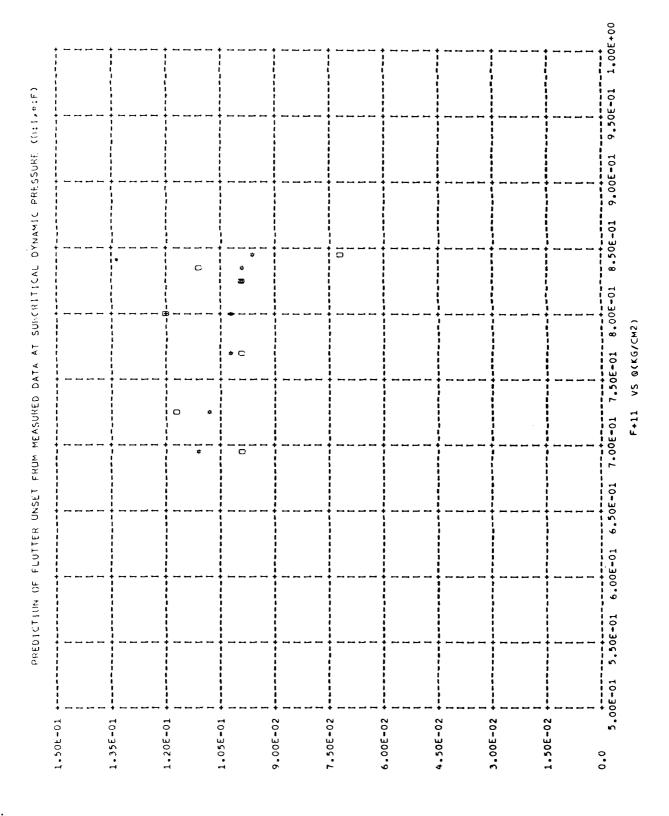


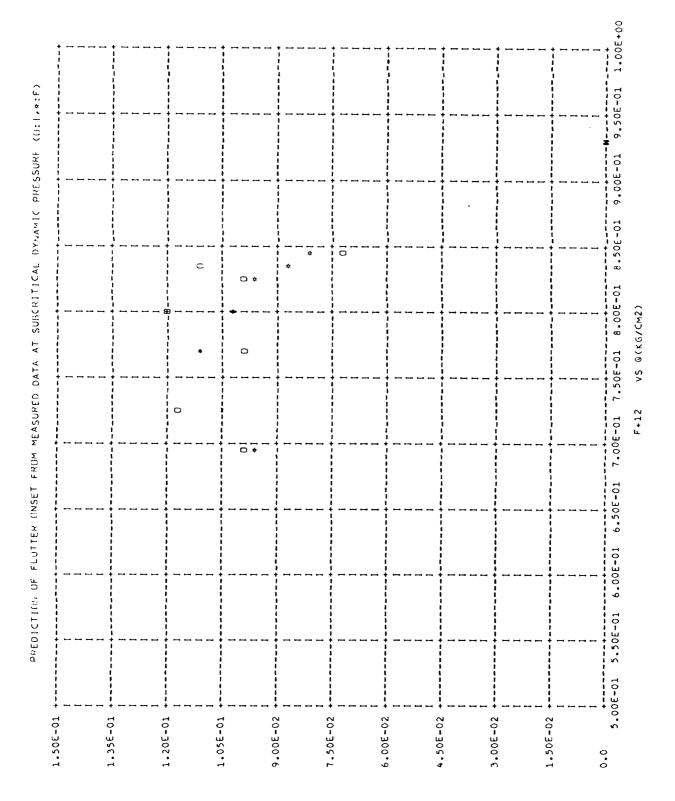


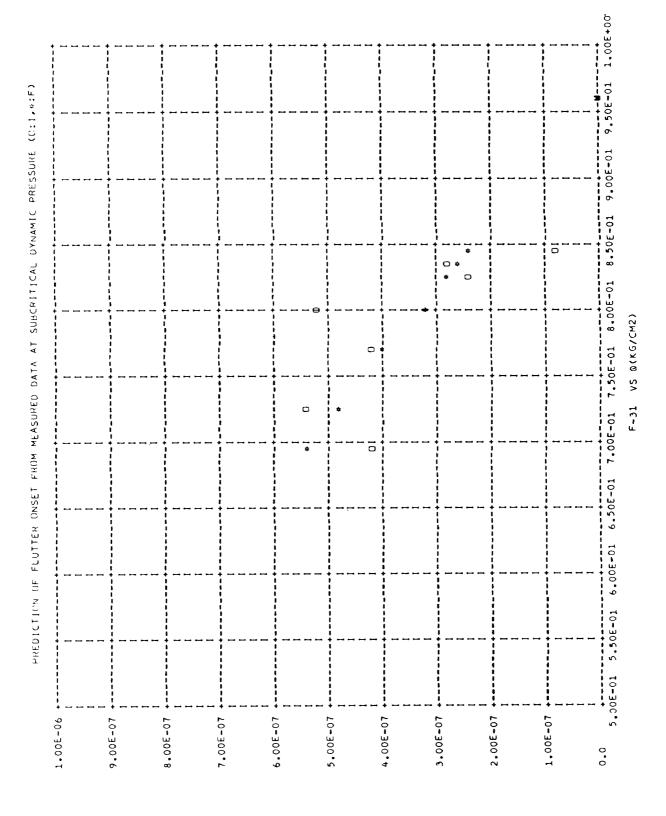


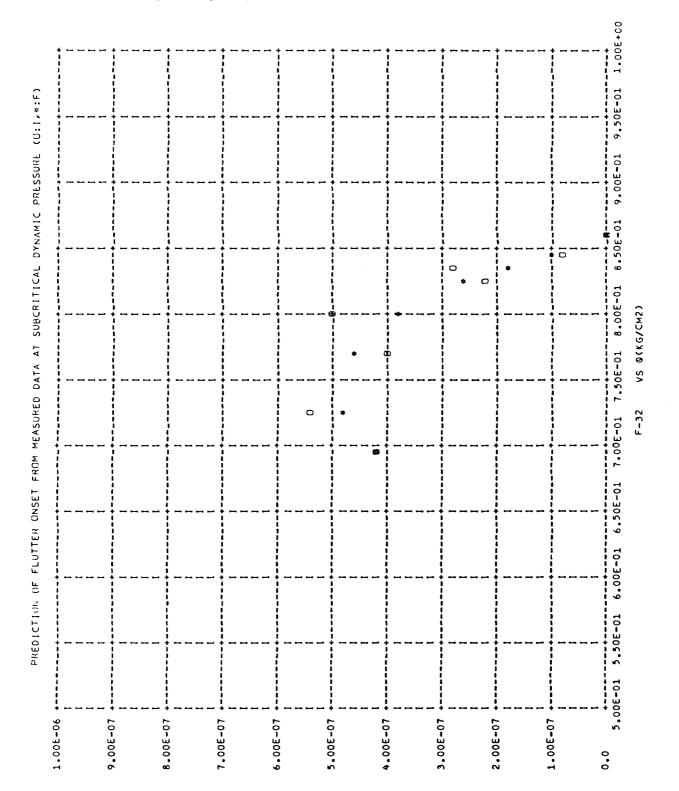


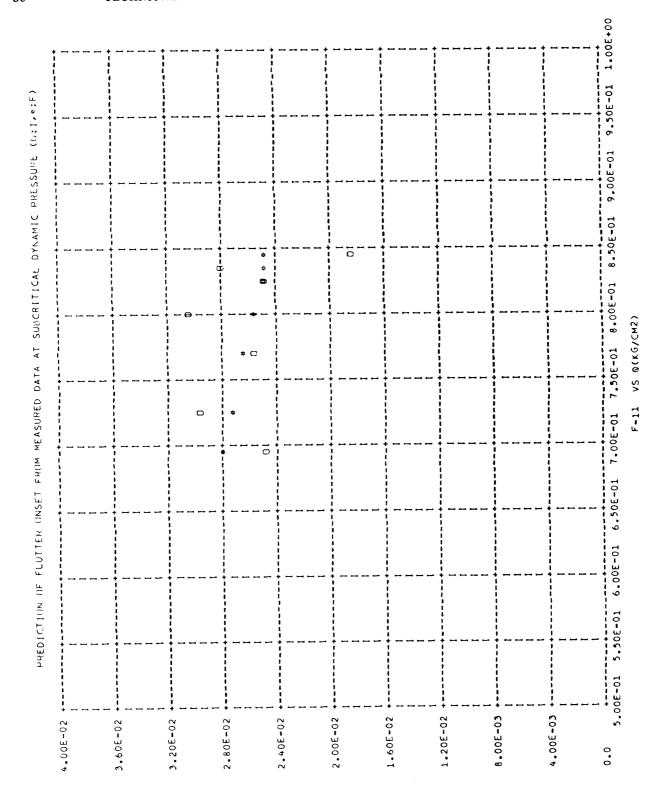
5.00E-01 5.50E-01 6.00E-01 6.50E-01 7.00E-01 7.50E-01 8.00E-01 8.50E-01 9.00E-01 9.50E-01 1.00E+00 PPEDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUECRITICAL DYNAMIC PRESSURE (0:1,*:F) VS O(KG/CM2) F+11 1.40E+00 1.00E+00 4.00E-01 2.00E-01 2.00E+00 1.80E+00 1.60E+00 1.20E+00 8.00E-01 6.00E-01 0.0

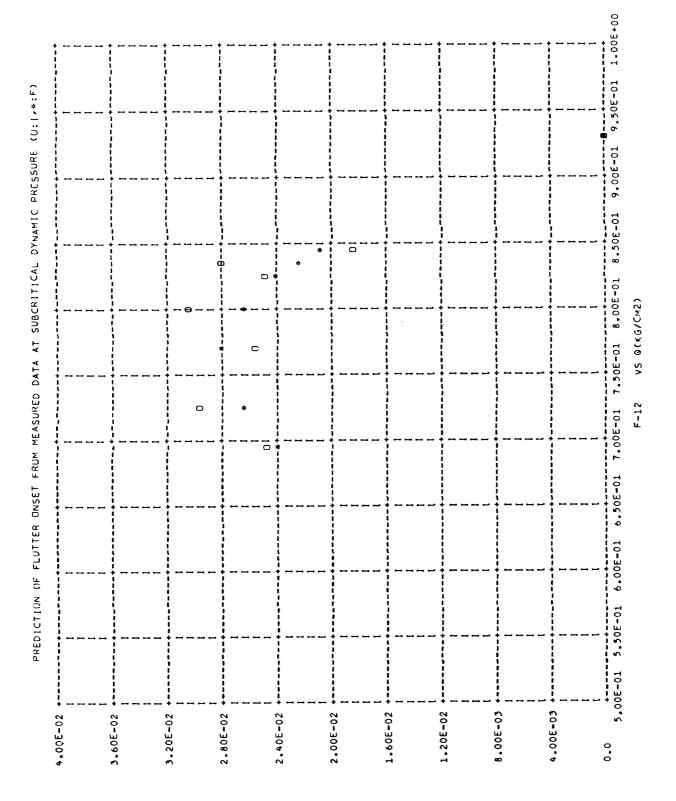


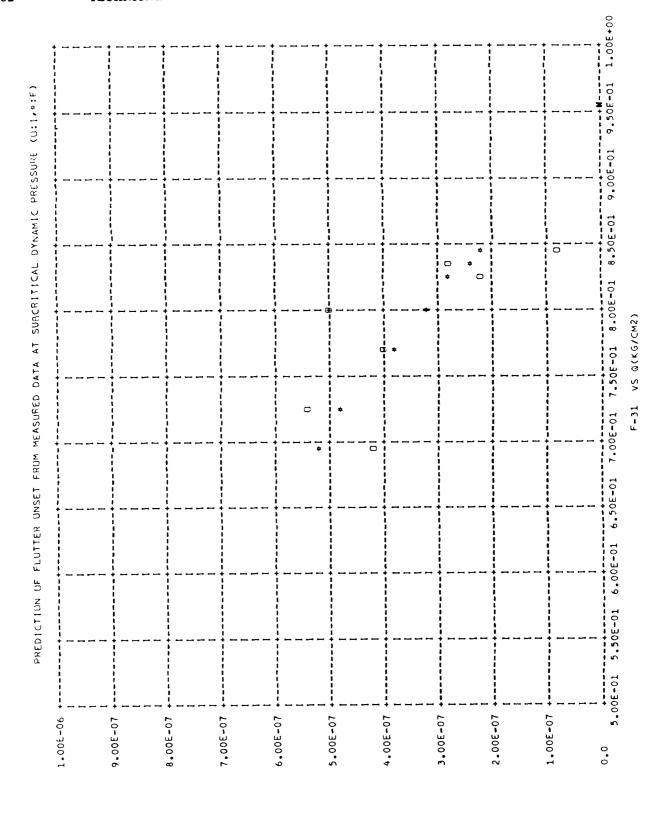


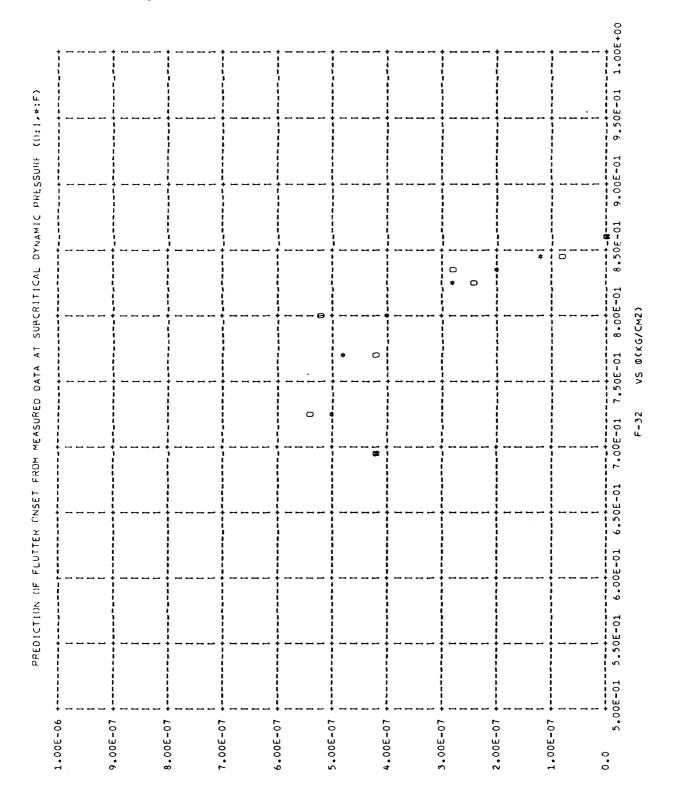












Program listing for JURY-CE8

```
KOUGIKEN NO HOOHOU NI YORU FURATSUTA ARUIWA DAIBAAZENSU GENKAI
        C
              SOKUDO NYOBI KUURIKIDANSEI TOKUSEI SUITEI NO KEISAN PURUGURAMU.
        C
              ESTIMATION OF BOUNDARY FOR FLUTTER OR DIVERGENCE AND AERUELASTIC
        C
              CHARACTERISTICS AT SUBCRITICAL SPEEDS WITH THE AID OF NAL.S
        C
        C
              METHOD.
              NAL ESBACS - 2 - 0005
        C
              C
              PRUGRAM JURY-CE8 COMPUTES JURY'S STABILITY PARAMETERS OF THE
        C
        C
              EIGHTH-ORDER EQUATION.
                    : DATA NO. FOR THE FIRST SET OF DATA, (USUALLY KO=1).
        C
              KAISU : DATA NO. FOR THE LAST SET OF DATA.
        C
        C
              QQ(KO): DYNAMIC PRESSURE.
              BO,...,B7 : AR COEFFICIENTS B(0),...,B(7).
        C
        C
              * STABILITY PARAMETERS *
        C
        C
        C
              G+1 AND G-1: G(1) AND G(-1)
              F+I AND F-I: DET(XI+YI) AND DET(XI-YI) FOR I=1,3,5,7.
        C
              FOR EXAMPLE, F-1 : DET(X1-Y1).
000001
              REAL *8 SPMD(12), SBM( 9, 9)
000002
              REAL#8
                        B8(12),B7(12),B6(12),B5(12)
              REAL #8
                        B4(12),B3(12),B2(12),B1(12),B0(12)
000003
000004
              DIMENSION SX( 7, 7), SY( 7, 7), SHI( 7, 7)
              DIMENSION CC(13), PD(12)
000005
              DIMENSION D1(21),D2(21),D5(21),D6(21),D7(21),D8(21)
000006
000007
              DIMENSION E5(21), E6(21), E7(21), E8(21), QQ(42)
        \mathsf{CC}
800000
              READ(5,556) KO, KAISU
000009
              WRITE(6,100)
000010
              M = 8
000011
          555 CONTINUE
000012
              READ(5,500) 00(KO)
              B8(K0)=1.0
000013
000014
              READ(5,510) B7(K0),B6(K0),B5(K0),B4(K0)
                          ,B3(K0),B2(K0),B1(K0),B0(K0)
000015
              D1(KO)=B8(KO)+B6(KO)+B4(KO)+B2(KO)+B0(KO)+
                      (B7(KO)+B5(KO)+B3(KO)+B1(KO))
000016
              D2(KO) = B8(KO) + B6(KO) + B4(KO) + B2(KO) + B0(KO) =
                      (B7(K0)+B5(K0)+B3(K0)+B1(K0))
        CC
000017
              CC(1)=BO(KO)
000018
              CC(2)=B1(K0)
000019
              CC(3)=B2(K0)
              CC(4)=B3(K0)
000020
              CC(5) = B4(K0)
000021
              CC(6)=B5(K0)
000022
000023
              CC(7) = B6(K0)
              CC(8)=B7(K0)
000024
000025
              CC(9)=B8(K0)
              M0 = M - 1
000026
              M1=M+1
000027
              DO 95 I=1.M
000028
           95 PD(1)=0.0
000029
              CALL SAJT(M,M1,M0,CC,PD,SPMD,SBM,SX,SY,SHI)
000030
              D5(K0)=PD(1)
000031
000032
              D6(KO)=PD(2)
              D7(K0)=PD(3)
000033
              D8(KO)=PD(4)
000034
```

```
000035
              E5(KO) = PD(5)
000036
              E6(KO)=PD(6)
000037
              E7(K0)=PD(7)
000038
              E8(K0) = PD(8)
        CC
              PRINTS OUT :
000039
              WRITE(6,681) KO,00(KO),B8(KO),B7(KO),B6(KO),B5(KO),B4(KO)
              WRITE(6,181) KO,00(KO),B3(KO),B2(KO),B1(KO),B0(KO)
000040
              WRITE(6,682) KO,00(KO),D1(KO),E5(KO),E6(KO),E7(KO),E8(KO)
000041
000042
              WRITE(6,182) KO,QQ(KO),D2(KO),D5(KO),D6(KO),D7(KO),D8(KO)
        \mathsf{CC}
              PRINTS END
000043
              IF(KO.EQ.KAISU) GO TO 558
000044
              K0=K0+1
000045
              GO TO 555
000046
          558 CONTINUE
000047
              STOP
000048
          100 FORMAT(1H0,10X, TABLE OF AR COEF. AND STABILITY PARAMETERS',//>
000049
          681 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,' B8=',E13.5,2X,' B7=',
             * E13.5,2X,' B6=',E13.5,2X,' B5=',E13.5,2X,' B4=',E13.5,/)
000050
          181 FORMAT(1H ,'NO.=', 12, 2X,'0=', F7.4, 2X,' B3=', E13.5, 2X,' B2=',
             * E13.5,2X,' B1=',E13.5,2X,' B0=',E13.5,/)
          682 FORMAT(1H ,'NO.=',12,2X,'0=',F7.4,2X,' G+1=',E13.5,2X,' F-7=',
000051
             * E13.5,2X,' F-5=',E13.5,2X,' F-3=',E13.5,2X,' F-1=',E13.5,/)
          182 FORMAT(1H ,'NO.=', 12,2X,'0=', F7.4,2X,' G-1=', E13.5,2X,' F+7=',
000052
             * E13.5,2X,' F+5=',E13.5,2X,' F+3=',E13.5,2X,' F+1=',E13.5,//)
000053
          500 FORMAT(F10.0)
000054
          510 FORMAT(4D20.10)
000055
          556 FORMAT(215)
000056
              END
```

```
000057
               SUBROUTINE SAUT(M,M1,M0,A,PD,PMD,BM,X,Y,HI)
               THIS SUBROUTINE PROGRAM IS USED FOR CALCULATION OF JURY'S
         C
         C
               STABILITY PARAMETERS.
               INPUTS REQUIRED :
        C
         C
                  M : ORDER OF THE CHARACTERISTIC FQUATION.
         C
                  M : EVEN ONLY
         C
                  M1 : M+1
        C
                  MO : M-1
         C
                  A(M1) : COEFFICIENTS OF THE CHARACTERISTIC EQUATION.
               OUTPUTS:
        C
                  PD(M) : STABILITY DETERMINANTS.
000058
               REAL*8 PMD(M),BM(MO,MO),S
               DIMENSION PD(M), A(M1)
000059
000060
               DIMENSION X(MO,MO),Y(MO,MO),HI(MO,MO)
        CC
               INITIAL CLEARING : START
000061
               MD2=M/2
000062
               IH2=0
000063
               111=0
000064
               DO 100 I=1,MO
000065
               DO 100 J=1,MO
000066
               0.0=(L,1)X
000067
               0.0 = (U, I)Y
000068
           100 CONTINUE
        \mathsf{CC}
               INITIAL CLEARING : END
        \mathsf{CC}
               X(KK,I) COMPUTATION : START
000069
               DO 1100 KK=1,MO
000070
               DO 110 I=KK,MO
000071
               II = M1 + KK - I
000072
               X(KK,I)=A(II)
000073
           110 CONTINUE
000074
         1100 CONTINUE
        CC
               X(KK,I) COMPUTATION : END
        CC
               Y(KK,I) COMPUTATION: START
000075
               IM2=MO
000076
               DD 2100 KK=1,M0
000077
               DO 210 I=1, IM2
000078
               II=M1-KK-I
000079
               Y(KK,I)=A(II)
000080
           210 CONTINUE
000081
               IM2=IM2-1
000082
         2100 CONTINUE
        \mathsf{CC}
               Y(KK,I) COMPUTATION : END
               HI(I,J)=X(I,J)+Y(I,J)*P COMPUTATION : START
        CC
           300 CONTINUE
000083
000084
               IM1=MD2
000085
               P=1.0
000086
               IF(IH2.E0.1) P=-1.0
000087
               DO 3000 KK=1,MD2
000088
               IM2=M0
000089
               DD 320 I=1,MO
000090
               DO 320 J=1,MO
000091
               q*(U,I)Y+(U,I)X=(U,I)IH
000092
               BM(1,J)=0.0
000093
           320 CONTINUE
000094
               IM2=IM2-(MD2-IM1)#2
               DO 330 I=1, IM2
DO 330 J=1, IM2
000095
000096
               I I = MD2 - IM1 + I
000097
```

```
000098
              JJ=MD2-IM1+J
000099
              BM(I,J)=HI(II,JJ)
          330 CONTINUE
000100
              S=0.0
000101
              1F(1M2.E0.2) GO TO 332
000102
              IF(IM2.E0.1) GO TO 331
000103
000104
              ILL=0
              THIS PROGRAM USES A STANDARD SUBROUTINE MDETD(BM,MO,IM2,1.0D-14,S,
              ILL) TO GIVE THE VALUE S. OF THE DETERMINANT BM(IM2. IM2).
              CALL MDETD(BM,MO,IM2,1.0D-14,S,ILL)
000105
000106
              GO TO 333
          331 CONTINUE
000107
000108
              S=BM(1,1)
              GO TO 333
000109
          332 CONTINUE
000110
              S=(BM(1,1)*BM(2,2)-BM(1,2)*BM(2,1))
000111
              GD TO 333
000112
000113
          333 CONTINUE
              III = I + I + 1
000114
000115
              PMD(III)=S
              IF(ILL.NE.O) PMD(III)=9999.9
000116
000117
              IM1=IM1-1
         3000 CONTINUE
000118
              IF(IH2.EQ.1) GO TO 340
000119
000120
              1H2=1H2+1
              GD TO 300
000121
          340 CONTINUE
000122
        \mathsf{CC}
              HI(I,J)=X(I,J)+Y(I,J)*P COMPUTATION : END
              THE INPUTS TO THE MAIN PROGRAM : START
        CC
              DO 400 I=1,M
000123
000124
              PD(1)=SNGL(PMD(1))
          400 CONTINUE
000125
        CC
              THE INPUTS TO THE MAIN PROGRAM : END
              RETURN
000126
000127
              END
```

Input example for program JURY-CE8

1	- 9

α	~	7	A
4.5	`	٠,	41

-0.2715692377D+01 0.3842079297D+01 -0.4065511467D+01 0.3984584738D+01

 $-0.3721756970D + 01 \\ 0.2906377400D + 01 \\ -0.1489682187D + 01 \\ 0.3913684648D + 00 \\ 0.3913684648D + 0 \\ 0.3913684648D + 0 \\ 0.3913684648D + 0 \\ 0.3913684648D + 0 \\ 0.39136840 + 0 \\ 0.3913680 + 0 \\ 0.391$

0.591

-0.3357981809D+01 0.2760215840D+01 -0.1495700535D+01 0.4109626468D+00

0.745

-0.2899370966D+01 0.4129639291D+01 -0.4079726919D+01 0.3792268948D+01

-0.3658605802D+01 0.3148905740D+01 -0.1803834414D+01 0.5044672000D+00

0.760

0.796

-0.3055353207D+01 0.4617551593D+01 -0.4679205165D+01 0.4207004739D+01

 $-0.3934139659D+01 \\ 0.3426909547D+01 \\ 0.2012491650D+01 \\ 0.5761573568D+00 \\ 0.57615768D+00 \\$

0.829

-0.3182858025D+01 0.5046220343D+01 -0.5258827640D+01 0.4533574673D+01

-0.3818077890D+01 0.3106518021D+01 -0.1802072117D+01 0.5257021418D+00

0.839

- -0.3214077461D+01 0.5173210864D+01 -0.5449561651D+01 0.4663370830D+01
- -0.3826612151D+01 0.3042027174D+01 -0.1734830485D+01 0.4992287417D+00

0.861

- -0.3255758500D+01 0.5344256589D+01 -0.5782626509D+01 0.5079568758D+01
- -0.4162857411D+01 0.3202496055D+01 -0.1768643290D+01 0.4994606448D+00

0.902

- -0.3194140282D+01 0.5100088471D+01 -0.5281837934D+01 0.4473940944D+01
- -0.3711514060D+01 0.3027580949D+01 -0.1760075824D+01 0.5172326015D+00

Output for program JURY-CE8

TABLE OF AR CHEF. AND STARILITY PARAMETERS

NO.= 1 0	- 0 53//0	B8= 0.100000+01	B7= -0.27157D+01	D/- 0 30/310 01	0.404550.01		
	1= 0.5340	B3= -0.372180+01		86= 0.384210+01	85= -0.406550+01	B4 =	0.398460+01
	= 0.5340	G+1= 0.13177E+00	82= 0.29064D+01	81= -0.148970+01	80= 3.391370+00		
NO.= 1 0		G-1= 0.24117E+02	F-7= 0.25736E-02	F-5* 0.47654E-01	F-3= 0.18499E+00	F-1=	0.60863E+00
NO 1 0	1= 0.5540	0-1= 0.241178+02	F+7= 0.48808E+00	F+5= 0.88417E+00	F+3= 0.13349E+01	F+1=	0.13914E+01
ND.= 2 0	= 0.5910	B8= 0.100000+01	87= -0.267590+01	86= 0.364110+01	85= -0.365710+01	84=	0.351360+01
NO.= 2 6	= 0.5910	B3= -0.335800+01	82= 0.276020+01	81= -0.149570+01	B0= 0.41096D+00		
NO.= 2 0	= 0.5910	G+1= 0.13923E+00	F-7= 0.29284E-02	F-5= 0.62015E-01	F-3= 0.21245E+00	F-1=	0.58904E+00
NO.= 2 0	= 0.5910	G-1= 0.22513E+02	F+7= 0.63194E+00	F+5= 0.97033E+00	F+3= 0.13040E+01	F+1=	0.14110E+01
NO.= 3 0	= 0.7450	88= 0.100000+01	B7= -0.28994D+01	86= 0.412960+01	85= -0.407970+01	84=	0.379230+01
	= 0.7450	83= -0.365860+01	B2= 0.314890+01	B1= -0.18038D+01	80= 0.504470+00	0 1	0.577250.01
NO.= 3 0		G+1= 0.13374E+00	F-7= 0.10253E-02	F-5= 0.58379E-01	F-3= 0.21516E+00	F-1=	0.49553E+00
NO.= 3 0		G-1= 0.25017E+02	F+7= 0.53595E+00	F+5= 0.91759E+00	F+3= 0.11201E+01		0.15045E+01
							01170170101
NO.= 4 0	- 0.7600	B8= 0.10000D+01	B7= -0.31216D+01	86= 0.488750+01	B5= -0.517000+01	84=	0.465830+01
NO.= 4 0	- 0.7600	83= -0.411990+01	82= 0.334230+01	81= -0.186100+01	80= 0.510410+00		
NO.= 4 0	- 0.7600	G+1= 0.12604E+00	F-7= 0.51171E-03	F-5= 0.33633E-01	F-3= 0.28449E+00	F-1=	0.48959E+00
NO.= 4 0	· 0.7600	G-1= 0.28671E+02	F+7= 0.29507E+00	F+5= 0.11524E+01	F+3= 0.10634E+01	F+1=	0.15104E+01
NO. = 5 0	- 0.7960	88= 0.100000+01	B7= -0.30554D+01	B6= 0.46176D+01	85= -0.467920+01	84=	0.420700+01
NO.= 5 0	- 0.7960	B3= -0.393410+01	B2= 0.34269D+01	81= -0.201250+01	80= 0.57616D+00		
NO. = 5 0	• 0.7960	G+1= 0.14643E+00	F-7= 0.34472E-03	F-5= 0.32092E-01	F-3= 0.22121E+00	F-1=	0.42384E+00
NO.= 5 0	- 0.7960	G-1= 0.27509E+02	F+7= 0.31416E+00	F+5= 0.94201E+00	F+3= 0.98328E+00	F+1=	0.15762E+01
NO.= 6 0	= 0.8290	88= 0.10000D+01	87= -0.31829D+01	B6= 0.50462D+01	85= -0.525880+01	84=	0.453360+01
	= 0.8290	83= -0.381810+01	B2= 0.31065D+01	B1= -0.18021D+01	80= 0.525700+00	04-	0.475500.01
	= 0.8290	G+1= 0.15018E+00	F-7= 0.23250E-03	F-5= 0.33264E-01	F-3= 0.30592E+00	F-1=	0.47430E+00
	= 0.8290	G-1= 0.28274E+02	F+7= 0.31711E+00	F+5= 0.12317E+01	F+3= 0.11540E+01	F+1=	0.15257E+01
							01132312:01
NO.= 7 @	= 0.8390	88= 0.100000+01	87= -0.321410+01	86= 0.517320+01	85= -0.544960+01	84=	0.46634D+01
NO.= 7 0	= 0.8390	83= -0.382660+01	82= 0.304200+01	81= -0.173480+01	PJ= 0.49923D+00		
NO.= 7 0	= 0.8390	G+1= 0.15276E+00	F-7= 0.14865E-03	F-5= 0.25041E-01	F-3= 0.33861E+00	F-1=	0.500776+00
NU.= 7 G	= 0.8390	G-1= 0.28603E+02	F+7= 0.23895E+00	F+5= 0.12980E+01	F+3= 0.11696t+01	F+1=	0.149928+61
NU.= 8 6	= 0.8610	88= 0.100000+01	87= -0.325580+01	86= 0.534430+01	85= -0.578260+01	84=	0.507960+01
	= 0.8610	83= -0.416290+01	82= 0.320250+01	81= -0.17686D+01	RO= 0.49946D+00		0.70,,,,,
	= 0.8610	G+1= 0.15590E+00	F-7= 0.13050E-03	F-5= 0.27261E-01	F-3= 0.32070E+00	F-1=	0.50054E+00
NO.= 8 6		G-1= 0.30096E+02	F+7= 0.27626E+00	F+5= 0.13111E+01	F+3= 0.12089E+01		0+14995E+01
							· -
	0.9020	88= 0.10000D+01	B7= -0.31941D+01	B6= 0.51001D+01	85= -0.528180+01	84=	0.447390+01
NO.= 9 6		83= -0.371150+01	B2= 0.30276D+01	B1= -0.17601D+01	80= 0.517230+00		
	»= 0.9020	G+1= 0.17127E+00	F-7* 0.11178E-03	F-5= 0.26312E-01	F-3= 0.32033E+00	F-1=	0.48277E+00
NO.= 9 6	u= 0.9020	G-1= 0.28066E+02	F+7= 0.26486E+00	F+5= 0.12852E+01	F+3= 0.11676E+01	F+1=	0.15172E+01

Program listing for FRED

```
KOUGIKEN NO HOOHOU NI YORU FURATSUTA ARUIWA DAIBAAZENSU GENKAI
        C
               SOKUDO OYOBI KUURIKIDANSEI TOKUSEI SUITEI NO KEISAN PUROGURAMU.
        C
               ESTIMATION OF BOUNDARY FOR FLUTTER OR DIVERGENCE AND AEROELASTIC
        C
              CHARACTERISTICS AT SUBCRITICAL SPEEDS WITH THE AID OF NAL'S
        C
              METHOD.
        C
              NAL ESBACS - 1 - 0007
               ************************************
        C
        C
              PROGRAM FRED.
        Ċ
              CALCULATION OF FREQUENCIES AND DAMPING RATIOS.
        C
               THIS PROGRAM INPUTS THE ORDER AND COEFFICIENTS OF AR PART AND
              COMPUTES FREQUENCIES AND DAMPING RATIOS OF AN EQUIVALENT J-DEGREE-
        C
        Ċ
              OF-FREEDOM SYSTEM WITH VISCOS DAMPING.
                     : DATA NO. FOR THE FIRST SET OF DATA, (USUALLY KO=1).
              ΚO
              KAISU : DATA NO. FOR THE LAST SET OF DATA.
DT : SAMPLED INTERVAL
        C
        C
        C
                     : ORDER OF AR PART, M=10
              10
        C
                     : URDER OF MA PART, N=10-1=M-1=IP
               IP
                    : VARIANCE
              CXX0
              C(I), I=1, M : COEFFICIENTS OF AR PART
        CCC
               A(I), I=1, N : COEFFICIENTS OF MA PART
               F(I), I=1, M : FREQUENCIES
        C
              R(I), I=1, M : DAMPING RATIOS
000001
               IMPLICIT REAL *8 (A-H, U-Z)
              DIMENSION B(26), PR(25), PI(25), F(25), R(25)
000002
000003
              DIMENSION A(26), C(26)
        CC
000004
              READ(5,556) KO, KAISU
000005
              READ(5,500) 10, IP, DT
              M = I Q
000006
000007
              N=IP
        \mathsf{CC}
800000
          555 CONTINUE
000009
              WRITE(6,557) KO
        CC
000010
              READ(11) 10,1P,CXXO,(C(1),1=1,M),(A(1),1=1,N)
000011
              M1 = M + 1
              DO 5 1=1.M
000012
              II=I+1
000013
000014
              B(II)=C(I)
            5 CONTINUE
000015
000016
              B(1)=1.0
              WRITE(6,650)
000017
000018
              WRITE(6,600) DT,M,(J,B(J),J=1,M1)
              THIS PROGRAM USES A STANDARD SUBROUTINE JARATO(B,M,1.0D-15,PR,PI,
              ILL) TO CALCULATE REAL AND IMAGINARY PARTS, PR AND PI , OF COMPLEX
        C
              ROOTS OF M-TH ORDER POLINOMIAL EQUATION WITH REAL COEFFICIENTS
              B(1),\ldots,B(M)
              CALL JARATD(8,M,1.0D-15,PR,PI,ILL)
000019
000020
              WRITE(6,610) ILL
000021
              IF(ILL.E0.0) GD TD 10
000022
              IF(ILL.E0.30000) STOP
000023
              IL1=ILL-1
000024
              WRITE(6,620)(J,PR(J),PI(J),J=1,IL1)
000025
              M=IL1
000026
           10 AT=0.5/DT
              P2=0.159154943091895
000027
000028
              DO 20 J=1,M
```

```
000029
              P=PR(J)*PR(J)+PI(J)*PI(J)
000030
              PP=(PR(J)*PR(J)=PI(J)*PI(J))/P
              PR=DACUS(PP)
000031
000032
              F(J)=P0*AT*P2
               IF(PO.NE.0.0) GO TO 30
000033
               R(J) = 99999.
000034
              GO TO 20
000035
           30 R(J) = -DLOG(P)/PQ
000036
000037
           20 CONTINUE
        CC
               DO 3 I=1.M
000038
000039
               II=I
000040
              D() 2 J=1.M
               IF(F(J)-F(II)) 1,2,2
000041
000042
            1 11=3
            2 CONTINUE
000043
000044
              FP1=F(1)
              FP2=R(I)
000045
000046
              FP3=PR(1)
              FP4=P1(1)
000047
000048
              F(I)=F(II)
000049
              R(I)=R(II)
000050
              PR(I)=PR(II)
              PI(I)=PI(II)
000051
000052
              F(II)=FP1
000053
              R(II)=FP2
000054
              PR(II)=FP3
000055
              PI(II)=FP4
            3 CONTINUE
000056
        CC
000057
              WRITE(6,630)
000058
              WRITE(6,640)(J,PR(J),PI(J),F(J),R(J),J=1,M)
        \mathsf{CC}
000059
              WRITE(51) M,N,DT,(F(I),I=1,M),(R(I),I=1,M)
000060
              CONTINUE
000061
               IF(KO.EO.KAISU) GO TO 559
000062
               KO = KO + 1
              GO TO 555
000063
000064
          559 CONTINUE
000065
               STOP
          500 FORMAT(215,F10.0)
000066
          510 FORMAT(4D20.10)
000067
000068
          556 FORMAT(215)
000069
          557 FORMAT(1H1,' NO.=', 15,//)
000070
          600 FORMAT(1H /5x, 'SAMPLING PERIOD(SEC) DT=',D10.3,5x,'ORDER OF CHARAC
             ATERISTIC EQ. M=',15/5X,'COEFFICIENT OF EQ.'/(10X,13,D25.16))
000071
          610 FORMAT(/ ,5X,8H*RESULT*,5X,4HILL=15)
          620 FORMAT(10X,13,2025.16)
000072
000073
          630 FORMAT(1H ,2H M,3X,12HREAL PART(M),14X,17HIMAGINARY PART(M),14X,
                              12HFREQUENCY(M),8X,16HDAMPING RATIO(M))
000074
          640 FORMAT(13,2x,D25.16,2x,D25.16,2x,D20.10,2x,D20.10)
000075
          650 FORMAT(1HO, DETERMINANT OF FREQ. AND DAMPING FROM COEF. OF AR(1)
             AIN AR-MA MODEL BY JARRATT MODIFIED METHOD')
000076
              END
```

DAMPING RATIO(M) 0.7969857998D-01 0.7969857998D-01

FRED	
program	
for pr	
ole	
exam	
Input	

1 11

1 0.001

2

// EXPAND USDK, RNO=11, FILE='C01.M2015'

// EXPAND USDK, RNO=51, FILE='C01.M2056', DISP=NEW, RECFM=VBS

Output for program FRED

NO. H

DETERMINANT OF FREG. AND DAMPING FROM COEF. OF AR(1) IN AR_MA MODEL BY JARRATT MODIFIED METHOD ~ Σ ORDER OF CHANACTERISTIC EG. SAMPLING PERIOD(SEC) DT= 0.1000-02 COEFFICIENT OF E0. 0.10000000000000000000+01 -0.1981765129499938D+01 0.9877462556321171D+00

FREQUENCY(M) 0.1231070558D+02 0.1231070558D+02 IMAGINARY PART(M)
0.7679842776151434D-0:
-0.7679842776151434D-0: 0.9908825647499690D+00 0.9908825647499691D+00 0 1.L.= REAL PART(M) *RESULT* $\Sigma + 0$

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REFERENCES

- [1] Matsuzaki, Y., and Ando, Y., "New Estimation Method for Flutter or Divergence Boundary from Random Responses at Subcritical Speeds," NAL TR—667T, National Aerospace Laboratory, Tokyo, April 1981.
- [2a] Matsuzaki, Y., and Ando, Y., "Estimation of Flutter Boundary from Random Responses Due to Turbulence at Subcritical Speeds," J. of Aircraft, Vol. 18, No. 10, October 1981, pp. 862 868.
- [2b] Matsuzaki, Y., and Ando, Y., "Reply to the Technical Comment on Estimation of Flutter Boundary from

- Random Responses Due to Turbulence at Subcritical Speeds," J. of Aircraft, Vol. 19, No. 7, July 1982, p. 606.
- [3] Ando, Y., Matsuzaki, Y., Ejiri, H., and Kikuchi, T., "The Estimation Method on Flutter Boundary from Subcritical Random Responses Due to Air Turbulence Problems in Test Procedure and Data Analysis (in Japanese)," NAL TR—718, National Aerospace Laboratory Tokyo, July 1982.
- [4] Akaike, H., Arahata, E., and Ozaki, T., "TIMSAC—74, A Time Series Analysis and Control Program Package (1)," Computer Science Monographs, No. 5, The Institute of Statistical Mathematics, Tokyo, March 1975.
- [5] Jury, I.E., Theory and Application of the z-Transform Method, John Wiley, New York, 1964.

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