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A
Análise de Estabilidade

```
 FORSTAB                              VERSION 1.72              (MAY 21 2004 )
      COMPUTER PROGRAM  RESP2V3

     LABVIB-PUC  - Análise de estabilidade


Data read from file: C:\romac\FORSTAB\Examp1\Forstab\pucFORST\stabPuc6.dat

Output File: C:\romac\FORSTAB\Examp1\Forstab\pucFORST\stabpuc6.out

Plot File: C:\romac\FORSTAB\Examp1\Forstab\pucFORST\stabpuc6.plt

Speed Case : 14

 Rotor  1 =  4800.0000 (rpm)

 EIGVAL   DAMPING     DAMPED     UNBALANCE     AMP.        LOG         NO.
   NO.    EXPONENT   FREQUENCY   FREQUENCY    FACTOR    DECREMENT     ITER
          (1/SEC)      (RPM)       (RPM)      (DIM)      (DIM)
 ---------------------------------------------------------------------------
    1  0.1765E+00 0.2329E+04 0.2329E+04 -.6909E+03 -.4547E-02     12
    2  -.7413E+00 0.2359E+04 0.2359E+04 0.1666E+03 0.1885E-01      5
    3  -.1443E+03 0.2443E+04 0.3900E+04 0.1169E+01 0.3543E+01      6
    4  -.1682E+02 0.3236E+05 0.3236E+05 0.1008E+03 0.3118E-01     18
    5  -.7009E+01 0.3235E+05 0.3235E+05 0.2417E+03 0.1300E-01      5
    6  -.2689E+05 0.2837E-06                                      6


Speed Case:  14      Mode Number:   1
Eigenvalue= 0.176546785E+00 +/- 0.243935245E+03 j
Damped Frequency=    2329. rpm
Log Decrement= -0.004547

Rotor Number:   1

       Bancada Mestrado PUC 2 -  Como construido


                    ROTOR  -- UMA RODA  IN SYNCHRONOUS WHIRL


Rotor Data read from File: C:\romac\CRTSP2\pucCRTP\rotpuc5.mod

Rotor Speed: 4800.0000 rpm

  St    Major     Minor    Ellipse    Phase    Rotor     Phase  X-Z Plane Y-Z Plane
   #    axis      axis      angle     angle amplitude    angle  amplitude amplitude
 ---------------------------------------------------------------------------------
   1  0.104E+01 0.940E+00   49.63   -37.48 0.100E+01   95.69  -.996E-01 -.100E+01
   2  0.396E+01 0.358E+01   49.63   -35.28 0.384E+01   97.81  -.522E+00 -.380E+01
   3  0.685E+01 0.618E+01   49.63   -34.94 0.664E+01   98.14  -.940E+00 -.657E+01
   4  0.136E+02 0.123E+02   49.63   -34.68 0.132E+02   98.40  -.193E+01 -.131E+02
   5  0.187E+02 0.168E+02   49.63   -34.56 0.181E+02   98.51  -.267E+01 -.179E+02
   6  0.208E+02 0.188E+02   49.63   -34.49 0.202E+02   98.57  -.301E+01 -.199E+02
   7  0.190E+02 0.171E+02   49.63   -34.45 0.184E+02   98.61  -.275E+01 -.182E+02
   8  0.181E+02 0.163E+02   49.63   -34.45 0.175E+02   98.62  -.262E+01 -.173E+02
   9  0.171E+02 0.155E+02   49.63   -34.44 0.166E+02   98.62  -.249E+01 -.164E+02
  10  0.129E+02 0.116E+02   49.63   -34.43 0.125E+02   98.63  -.188E+01 -.124E+02
  11  0.694E+01 0.626E+01   49.63   -34.43 0.673E+01   98.63  -.101E+01 -.665E+01
  12  0.113E+00 0.102E+00   49.63   -34.40 0.109E+00   98.66  -.164E-01 -.108E+00
  13  0.715E+01 0.645E+01   49.63   -34.44 0.693E+01  -81.38  0.104E+01 0.686E+01
  14  0.103E+02 0.927E+01   49.63   -34.44 0.996E+01  -81.38  0.149E+01 0.985E+01
  15  0.145E+02 0.130E+02   49.63   -34.44 0.140E+02  -81.38  0.210E+01 0.139E+02


Speed Case:  14      Mode Number:   2
Eigenvalue= -.741317715E+00 +/- 0.247037405E+03 j
Damped Frequency=    2359. rpm
Log Decrement=  0.018855
```

Rotor Speed: 4800.0000 rpm

St #	Major axis	Minor axis	Ellipse angle	Phase angle	Rotor amplitude	Phase angle	X-Z Plane amplitude	Y-Z Plane amplitude
1	0.100E+01	-.432E+00	-85.33	-2.02	0.100E+01	86.20	0.665E-01	-.100E+01
2	0.122E+02	-.525E+01	-85.33	-71.55	0.629E+01	137.58	-.465E+01	-.425E+01
3	0.240E+02	-.103E+02	-85.33	-73.83	0.120E+02	141.39	-.934E+01	-.746E+01
4	0.523E+02	-.225E+02	-85.33	-75.28	0.255E+02	143.95	-.206E+02	-.150E+02
5	0.742E+02	-.320E+02	-85.33	-75.82	0.359E+02	144.93	-.294E+02	-.207E+02
6	0.846E+02	-.364E+02	-85.33	-76.13	0.408E+02	145.52	-.336E+02	-.231E+02
7	0.781E+02	-.337E+02	-85.33	-76.30	0.376E+02	145.83	-.311E+02	-.211E+02
8	0.745E+02	-.321E+02	-85.33	-76.32	0.358E+02	145.87	-.296E+02	-.201E+02
9	0.708E+02	-.305E+02	-85.33	-76.34	0.340E+02	145.90	-.282E+02	-.191E+02
10	0.535E+02	-.230E+02	-85.33	-76.38	0.257E+02	145.98	-.213E+02	-.144E+02
11	0.287E+02	-.124E+02	-85.33	-76.38	0.138E+02	145.97	-.114E+02	-.773E+01
12	0.471E+00	-.203E+00	-85.33	-76.52	0.226E+00	146.24	-.188E+00	-.126E+00
13	0.295E+02	-.127E+02	-85.33	-76.34	0.142E+02	-34.10	0.118E+02	0.796E+01
14	0.424E+02	-.183E+02	-85.33	-76.33	0.204E+02	-34.11	0.169E+02	0.114E+02
15	0.597E+02	-.257E+02	-85.33	-76.33	0.287E+02	-34.11	0.238E+02	0.161E+02

Speed Case: 14 Mode Number: 3
Eigenvalue= -.144299776E+03 +/- 0.255874784E+03 j
Damped Frequency= 2443. rpm
Log Decrement= 3.543383

Rotor Speed: 4800.0000 rpm

St #	Major axis	Minor axis	Ellipse angle	Phase angle	Rotor amplitude	Phase angle	X-Z Plane amplitude	Y-Z Plane amplitude
1	0.110E+01	0.962E+00	-30.42	56.08	0.101E+01	82.83	0.126E+00	-.100E+01
2	0.117E+01	0.102E+01	-30.42	52.93	0.108E+01	79.55	0.195E+00	-.106E+01
3	0.121E+01	0.106E+01	-30.42	50.02	0.113E+01	76.58	0.261E+00	-.110E+01
4	0.116E+01	0.102E+01	-30.42	42.07	0.110E+01	68.66	0.400E+00	-.103E+01
5	0.899E+00	0.785E+00	-30.42	29.61	0.872E+00	56.82	0.478E+00	-.730E+00
6	0.597E+00	0.521E+00	-30.42	6.16	0.596E+00	35.81	0.483E+00	-.349E+00
7	0.432E+00	0.377E+00	-30.42	-21.56	0.425E+00	11.39	0.416E+00	-.838E-01
8	0.406E+00	0.355E+00	-30.42	-25.31	0.397E+00	7.98	0.394E+00	-.552E-01
9	0.383E+00	0.334E+00	-30.42	-29.52	0.372E+00	4.11	0.371E+00	-.267E-01
10	0.289E+00	0.252E+00	-30.42	-37.88	0.275E+00	-3.77	0.275E+00	0.181E-01
11	0.155E+00	0.135E+00	-30.42	-37.57	0.148E+00	-3.47	0.147E+00	0.893E-02
12	0.282E-02	0.246E-02	-30.42	-64.89	0.253E-02	-31.36	0.216E-02	0.132E-02
13	0.159E+00	0.138E+00	-30.42	-29.22	0.154E+00	-175.62	-.154E+00	0.118E-01
14	0.228E+00	0.199E+00	-30.42	-28.28	0.222E+00	-174.74	-.221E+00	0.203E-01
15	0.321E+00	0.280E+00	-30.42	-27.48	0.313E+00	-174.01	-.311E+00	0.326E-01

Speed Case : 19

Rotor 1 = 7000.0000 (rpm)

EIGVAL NO.	DAMPING EXPONENT (1/SEC)	DAMPED FREQUENCY (RPM)	UNBALANCE FREQUENCY (RPM)	AMP. FACTOR (DIM)	LOG DECREMENT (DIM)	NO. ITER
1	0.1552E+01	0.2342E+04	0.2342E+04	-.7901E+02	-.3976E-01	14
2	-.7281E+00	0.2359E+04	0.2359E+04	0.1697E+03	0.1852E-01	5
3	-.1693E+03	0.3646E+04	0.4868E+04	0.1349E+01	0.2786E+01	6
4	-.1992E+02	0.3236E+05	0.3236E+05	0.8508E+02	0.3693E-01	17
5	-.8318E+01	0.3235E+05	0.3235E+05	0.2036E+03	0.1543E-01	5
6	-.2288E+05	0.3126E-06				6

Speed Case: 19 Mode Number: 1
Eigenvalue= 0.155189027E+01 +/- 0.245228472E+03 j
Damped Frequency= 2342. rpm
Log Decrement= -0.039762

Rotor Speed: 7000.0000 rpm

St #	Major axis	Minor axis	Ellipse angle	Phase angle	Rotor amplitude	Phase angle	X-Z Plane amplitude	Y-Z Plane amplitude

1	0.100E+01	0.860E+00	79.20	-9.27	0.100E+01	92.85	-.498E-01	-.100E+01
2	0.448E+01	0.384E+01	79.20	19.96	0.441E+01	118.06	-.208E+01	-.389E+01
3	0.807E+01	0.691E+01	79.20	23.50	0.790E+01	121.20	-.409E+01	-.676E+01
4	0.166E+02	0.142E+02	79.20	26.09	0.162E+02	123.54	-.894E+01	-.135E+02
5	0.230E+02	0.197E+02	79.20	27.15	0.224E+02	124.49	-.127E+02	-.185E+02
6	0.259E+02	0.222E+02	79.20	27.79	0.252E+02	125.07	-.145E+02	-.206E+02
7	0.238E+02	0.203E+02	79.20	28.13	0.231E+02	125.39	-.133E+02	-.188E+02
8	0.226E+02	0.194E+02	79.20	28.17	0.220E+02	125.42	-.127E+02	-.179E+02
9	0.215E+02	0.184E+02	79.20	28.21	0.208E+02	125.46	-.121E+02	-.170E+02
10	0.162E+02	0.139E+02	79.20	28.30	0.157E+02	125.53	-.914E+01	-.128E+02
11	0.872E+01	0.746E+01	79.20	28.29	0.845E+01	125.53	-.491E+01	-.688E+01
12	0.142E+00	0.122E+00	79.20	28.59	0.138E+00	125.80	-.805E-01	-.112E+00
13	0.897E+01	0.768E+01	79.20	28.21	0.870E+01	-54.54	0.505E+01	0.709E+01
14	0.129E+02	0.110E+02	79.20	28.20	0.125E+02	-54.55	0.725E+01	0.102E+02
15	0.181E+02	0.155E+02	79.20	28.20	0.176E+02	-54.56	0.102E+02	0.143E+02

Speed Case: 19 Mode Number: 2
Eigenvalue= -.728087212E+00 +/- 0.247050994E+03 j
Damped Frequency= 2359. rpm
Log Decrement= 0.018517

Rotor Speed: 7000.0000 rpm

St #	Major axis	Minor axis	Ellipse angle	Phase angle	Rotor amplitude	Phase angle	X-Z Plane amplitude	Y-Z Plane amplitude
1	0.100E+01	-.497E+00	-87.49	-1.25	0.100E+01	88.11	0.330E-01	-.100E+01
2	0.124E+02	-.615E+01	-87.49	-71.58	0.703E+01	143.64	-.566E+01	-.417E+01
3	0.244E+02	-.121E+02	-87.49	-73.83	0.135E+02	147.20	-.113E+02	-.730E+01
4	0.533E+02	-.265E+02	-87.49	-75.25	0.290E+02	149.55	-.250E+02	-.147E+02
5	0.757E+02	-.376E+02	-87.49	-75.78	0.409E+02	150.45	-.356E+02	-.202E+02
6	0.862E+02	-.428E+02	-87.49	-76.09	0.464E+02	150.98	-.406E+02	-.225E+02
7	0.797E+02	-.396E+02	-87.49	-76.26	0.428E+02	151.27	-.376E+02	-.206E+02
8	0.759E+02	-.377E+02	-87.49	-76.27	0.408E+02	151.30	-.358E+02	-.196E+02
9	0.722E+02	-.358E+02	-87.49	-76.29	0.388E+02	151.33	-.340E+02	-.186E+02
10	0.545E+02	-.271E+02	-87.49	-76.33	0.293E+02	151.40	-.257E+02	-.140E+02
11	0.293E+02	-.146E+02	-87.49	-76.33	0.157E+02	151.40	-.138E+02	-.754E+01
12	0.481E+00	-.239E+00	-87.49	-76.47	0.258E+00	151.63	-.227E+00	-.122E+00
13	0.301E+02	-.150E+02	-87.49	-76.29	0.162E+02	-28.67	0.142E+02	0.777E+01
14	0.433E+02	-.215E+02	-87.49	-76.29	0.233E+02	-28.68	0.204E+02	0.112E+02
15	0.609E+02	-.302E+02	-87.49	-76.28	0.327E+02	-28.68	0.287E+02	0.157E+02

Speed Case: 19 Mode Number: 3
Eigenvalue= -.169302365E+03 +/- 0.381797463E+03 j
Damped Frequency= 3646. rpm
Log Decrement= 2.786184

Rotor Speed: 7000.0000 rpm

St #	Major axis	Minor axis	Ellipse angle	Phase angle	Rotor amplitude	Phase angle	X-Z Plane amplitude	Y-Z Plane amplitude
1	0.107E+01	0.966E+00	-34.07	53.17	0.100E+01	84.38	0.984E-01	-.100E+01
2	0.110E+01	0.998E+00	-34.07	51.51	0.104E+01	82.69	0.132E+00	-.103E+01
3	0.112E+01	0.101E+01	-34.07	49.90	0.106E+01	81.06	0.164E+00	-.104E+01
4	0.988E+00	0.892E+00	-34.07	45.02	0.941E+00	76.16	0.225E+00	-.914E+00
5	0.643E+00	0.580E+00	-34.07	35.20	0.623E+00	66.56	0.248E+00	-.571E+00
6	0.287E+00	0.259E+00	-34.07	1.57	0.287E+00	35.48	0.234E+00	-.167E+00
7	0.226E+00	0.204E+00	-34.07	-60.57	0.210E+00	-23.93	0.192E+00	0.850E-01
8	0.227E+00	0.205E+00	-34.07	-66.72	0.209E+00	-30.45	0.180E+00	0.106E+00
9	0.231E+00	0.209E+00	-34.07	-72.71	0.211E+00	-36.91	0.168E+00	0.126E+00
10	0.201E+00	0.181E+00	-34.07	-82.50	0.182E+00	-47.64	0.123E+00	0.134E+00
11	0.107E+00	0.967E-01	-34.07	-82.77	0.969E-01	-47.93	0.649E-01	0.719E-01
12	0.282E-02	0.254E-02	-34.07	74.57	0.256E-02	-72.93	0.752E-03	0.245E-02
13	0.949E-01	0.857E-01	-34.07	-73.79	0.864E-01	141.92	-.680E-01	-.533E-01
14	0.134E+00	0.121E+00	-34.07	-72.66	0.122E+00	143.15	-.978E-01	-.733E-01
15	0.186E+00	0.168E+00	-34.07	-71.67	0.170E+00	144.22	-.138E+00	-.992E-01

B
Propriedades do mancal para 4.100 rpm

```
 MaxBrg Output File
 MAXBRG Version 3.0 (May 2005)

 Fitzgerald and Neal Bearing, MAXBRG Bancada Puc
 (MaxBrg Data File) Minhui He, May 2003
 Fixed Geometry Bearing
 Regular Flooded Flow Condition

OVERALL GEOMETRY:
 Journal Diameter=  0.787 IN     Radial Clearance (Cb) =0.00118 IN
 Pad Thickness=         0.390   IN

 PAD GEOMETRY (DEG, IN)
 Pad #   Pivot Angle   Arc Length   Axial Length   Preload   Offset
   1       90.00         150.00        0.31         0.00      0.50
   2      270.00         150.00        0.31         0.00      0.50
 Pad #   Inlet Angle   Taper Depth   Taper Arc Length
   1       15.00         0.00           0.00
   2      195.00         0.00           0.00

LUBRICANT PROPERTIES:
   Mu( 104.0 F)      =0.4090E-05 LB-SEC/IN2
   Mu( 212.0 F)      =0.7880E-06 LB-SEC/IN2

 Lubricant Density= 0.800E-04 LB-S2/IN4
 Lubricant Specific Heat= 0.180E+03 BTU-IN/(LB-S2-F)
 Lubricant Heat Conductivity=0.2000E-05 BTU/(IN-S-F)
 Lubricant Supply Temperature=   90.00 F
 Pad Heat conductivity =0.1160E-02 BTU/(IN-S-F)

BEARING MATERIAL PROPERTIES:
 Pad Youngs Modulus=0.1500E+08 LB/IN2
 Pad Poissons Ratio=0.38
 Manufacturing Temperature=70.00 F
 Pad Thermal Expansion=0.9600E-05 1/F

OPERATING CONDITION:
 Shaft Speed    Ws        Fx       Fy       Qsupply     Whirl Ratio
   4100.0       1.2       0.0      0.0        0.050         1.00
 High Ambient Pressure=   0.000 PSI
 Low Ambient Pressure=    0.000 PSI
 Cavitation Pressure=     0.000 PSI
 Lubricant Supply Pressure=     0.000 PSI
 Leading/Trailing Edge Heat Convection Coefficients:
   h=0.2500E-03 BTU/(S-IN2-F)
 Hot Oil Carry-Over Factor=    0.80
 Lower Critical Re = 500.00
 Upper Critical Re =1000.00

SELECTED OPTIONS:
 Thermal Effects with Conduction Included
 Journal Temperature Model: Averaged Film Temperature
 Ambient Temperature Equals Supply Temperature
 Supply Lubricant Used in Groove Mixing Model
 Pad Mechanical and Thermal Deformation Included
 Journal Equilibrium Position Matches the Load


SPEED/LOAD CASE # 1
 Speed(RPM)=  4100.0  Specific Load(PSI)=     4.9
 Applied Loads(LBF): X=     0.0    Y=     0.0    Total=     1.2
 Sommerfeld Number=  7.8447
```

```
MAXBRG RESULTS OF CASE # 1:
 Operating Journal Position:   (Xj/Cb)=  0.1016   (Yj/Cb)= -0.0208
 Eccentricity Ratio=0.10   Attitude Angle=  78.4 Deg

 Calculated Hydrodynamic Forces:   Fx=     0.00 LB   Fy=     1.21 LB
 Power loss (HP)=   0.010

 Pad #     Hin (IN)     Hexit (IN)     Hmin (IN)     Fx (LB)     Fy (LB)
   1      0.107E-02     0.130E-02      0.107E-02        0.00        0.00
   2      0.129E-02     0.106E-02      0.106E-02        0.00        1.21
 Journal Temperature=  100.76 F
 Maximum Pad Temperature=  100.83 F on Pad # 1
 Maximum Pressure=    9.88 Psi on Pad # 2
 The sump temperature=   92.48 F

 Pad #     Tin (F)     Texit (F)     Texit (F, Bulk)     hback (BTU/(S-IN2-
   1        98.78       101.02          101.13              0.2500E-03
   2        97.42       101.04          101.13              0.2500E-03
 Flow Rates(GPM)
 Pad #     Carryover     Inlet     Exit     Side
   1          0.01         0.01     0.01     0.00
   2          0.01         0.01     0.01     0.00
 Differential Flow Rate=   0.00 GPM
 Journal Thermal Expansion=  0.0000     IN
 Shell Thermal Expansion=  0.0000     IN

Reduced Stiffness Coefficients (LB/IN)
 Kxx=  1824.3          Kxy=  4387.6
 Kyx= -10304.          Kyy=  1718.2

Reduced Damping Coefficients (LB-S/IN)
 Cxx=  20.851          Cxy= -4.2448
 Cyx= -4.2448          Cyy=  47.816
Rigid Rotor Stability Threshold Speed =  0.12852686E+05 RPM
Whirl Frequency Ratio = 0.501
 Laminar Flow Predicted on Pad # 1
 Laminar Flow Predicted on Pad # 2
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Detalhamento do mancal