## V21 Asymmetric Rotor Examples Part2 (Ver 21.20)

In Ver 21.20, a general finite element approach is used. This new feature will replaced the simplified version in Ver 21.10. All the examples presented in Ver 21.10 can be analyzed in Ver 21.20. Three additional examples (examples 6, 7 and 8) are presented in Ver 21.20 for more complex models. Examples are stored in files:

Asymmetric_Rotor_Example_1a.rot
Asymmetric_Rotor_Example_1b.rot
Asymmetric_Rotor_Example_2a.rot
Asymmetric_Rotor_Example_2b.rot
Asymmetric_Rotor_Example_2c.rot
Asymmetric_Rotor_Example_2d.rot
Asymmetric_Rotor_Example_2e.rot
Asymmetric_Rotor_Example_3a.rot
Asymmetric_Rotor_Example_3b.rot
Asymmetric_Rotor_Example_3c.rot
Asymmetric_Rotor_Example_4a.rot
Asymmetric_Rotor_Example_4b.rot
Asymmetric_Rotor_Example_4c.rot
Asymmetric_Rotor_Example_5a.rot
Asymmetric_Rotor_Example_5b.rot
Asymmetric_Rotor_Example_5c.rot
Asymmetric_Rotor_Example_6.rot
Asymmetric_Rotor_Example_7.rot
Asymmetric_Rotor_Example_8.rot

For more information on examples 1-5, see V21_Asymmetric_Rotor_Examples_Part1.

### Model Input

For the asymmetric shaft elements as illustrated in Example 8, the data are entered in the Shaft Elements Tab as shown below. For the asymmetric element, three additional inputs are required: Area, Ix, and Iy. Ix and Iy are the second moment of area about x and y axis. Area is the cross-section area of the element. For the axisymmetric element, enter zero or leave blank for the Area, Ix and Iy. The asymmetric disk data are entered in the Disks Tab as shown below. Jx and Jy are the mass moment of inertia about the x and y axis. Again, for symmetric disk, leave then zero or blank. All the other data are entered as before. Since in the rotating reference frame, the bearings are assume to be isotropic, therefore, mean values will be used in the asymmetric analysis.

Rotor Bearing System Data

Axial Forces | Static Loads | Constraints | Misalignments | Shaft Bow | Time Forcing | Harmonics | Base Motion | Torsional/Axial
Units/Description | Material | Shaft Elements | Disks | Unbalance | Bearings | Supports | Foundation | User's Elements

Shaft: 1 of 1 Starting Station #: 1 Add Shaft Del Shaft Previous Next

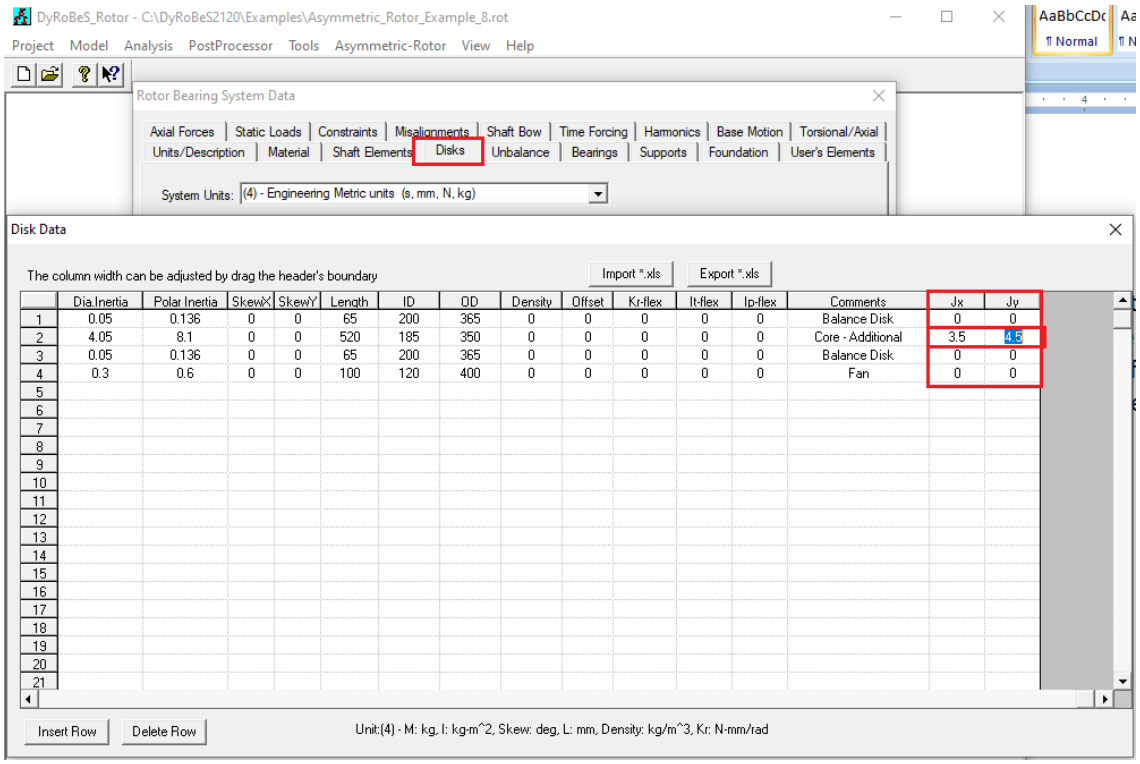
Speed Ratio: 2975 Axial Distance: 0 Y Distance: 0 Import *.xls Export *.xls

Comment: Motor 925 kW, 50 Hz, 2 Poles

| | Mass OD | Stiff ID | Stiff OD | Comments | Area | Ix | Iy |
|---|---|---|---|---|---|---|---|
| 1 | 120 | 0 | 0 | | 0 | 0 | 0 |
| 2 | 100 | 0 | 0 | | 0 | 0 | 0 |
| 3 | 70 | 0 | 0 | | 0 | 0 | 0 |
| 4 | 70 | 0 | 0 | Brg CL | 0 | 0 | 0 |
| 5 | 80 | 0 | 0 | | 0 | 0 | 0 |
| 6 | 100 | 0 | 0 | | 0 | 0 | 0 |
| 7 | 174 | 0 | 0 | | 0 | 0 | 0 |
| 8 | 190 | 0 | 0 | | 0 | 0 | 0 |
| 9 | 148 | 0 | 0 | | 0 | 0 | 0 |
| 10 | 180 | 0 | 0 | Balance Disk | 0 | 0 | 0 |
| 11 | 180 | 0 | 0 | | 0 | 0 | 0 |
| 12 | 180 | 0 | 0 | Core | 25450 | 4.1E+007 | 6.2E+007 |
| 13 | 180 | 0 | 0 | Core | 25450 | 4.1E+007 | 6.2E+007 |
| 14 | 180 | 0 | 0 | | 0 | 0 | 0 |
| 15 | 180 | 0 | 0 | | 0 | 0 | 0 |
| 16 | 180 | 0 | 0 | Balance Disk | 0 | 0 | 0 |
| 17 | 190 | 0 | 0 | | 0 | 0 | 0 |
| 18 | 175 | 0 | 0 | | 0 | 0 | 0 |
| 19 | 140 | 0 | 0 | | 0 | 0 | 0 |
| 20 | 119 | 0 | 0 | | 0 | 0 | 0 |

Insert Row Delete Row ReNumber Copy & Paste Unit:(4) - Length, Diameter: mm

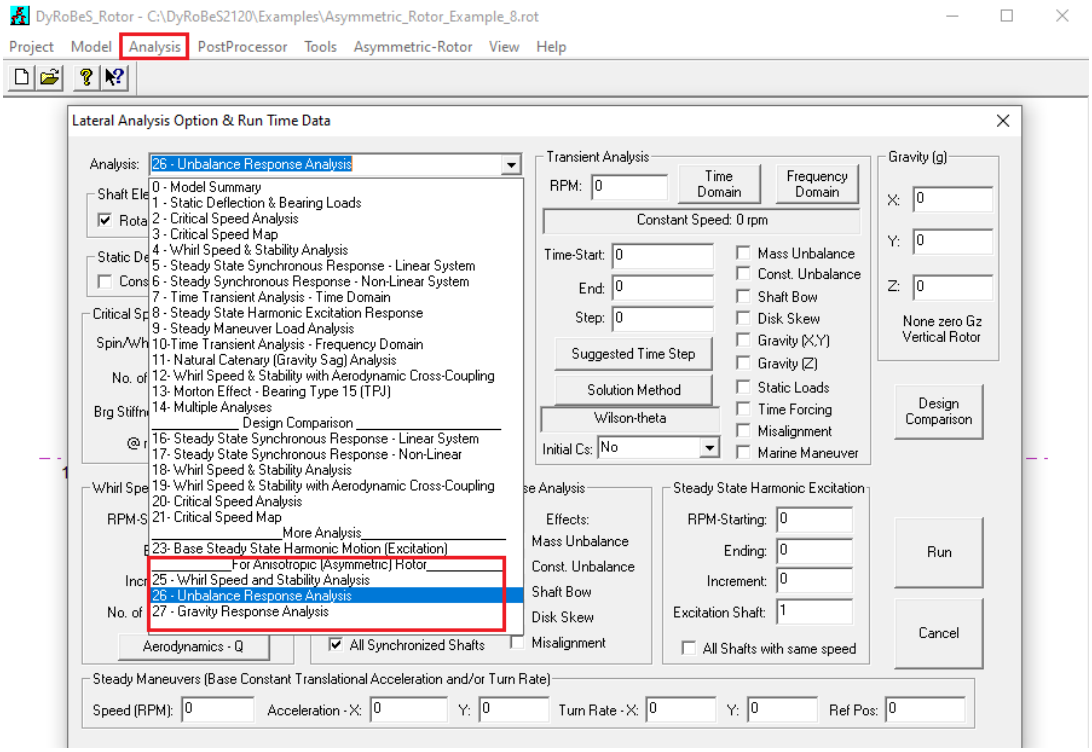
Tor K Save Save As Close Help

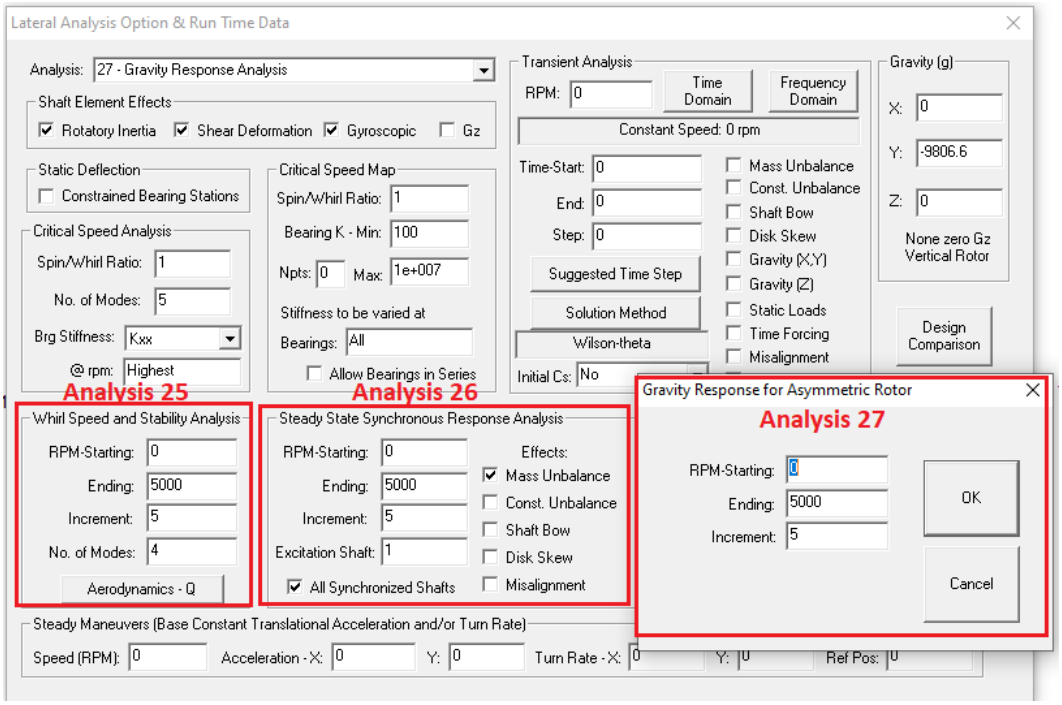



| | Dia.Inertia | Polar Inertia | SkewX | SkewY | Length | ID | OD | Density | Offset | Kr-flex | It-flex | Ip-flex | Comments | Jx | Jy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.05 | 0.136 | 0 | 0 | 65 | 200 | 365 | 0 | 0 | 0 | 0 | 0 | Balance Disk | 0 | 0 |
| 2 | 4.05 | 8.1 | 0 | 0 | 520 | 185 | 350 | 0 | 0 | 0 | 0 | 0 | Core - Additional | 3.5 | 4.5 |
| 3 | 0.05 | 0.136 | 0 | 0 | 65 | 200 | 365 | 0 | 0 | 0 | 0 | 0 | Balance Disk | 0 | 0 |
| 4 | 0.3 | 0.6 | 0 | 0 | 100 | 120 | 400 | 0 | 0 | 0 | 0 | 0 | Fan | 0 | 0 |

## Analysis

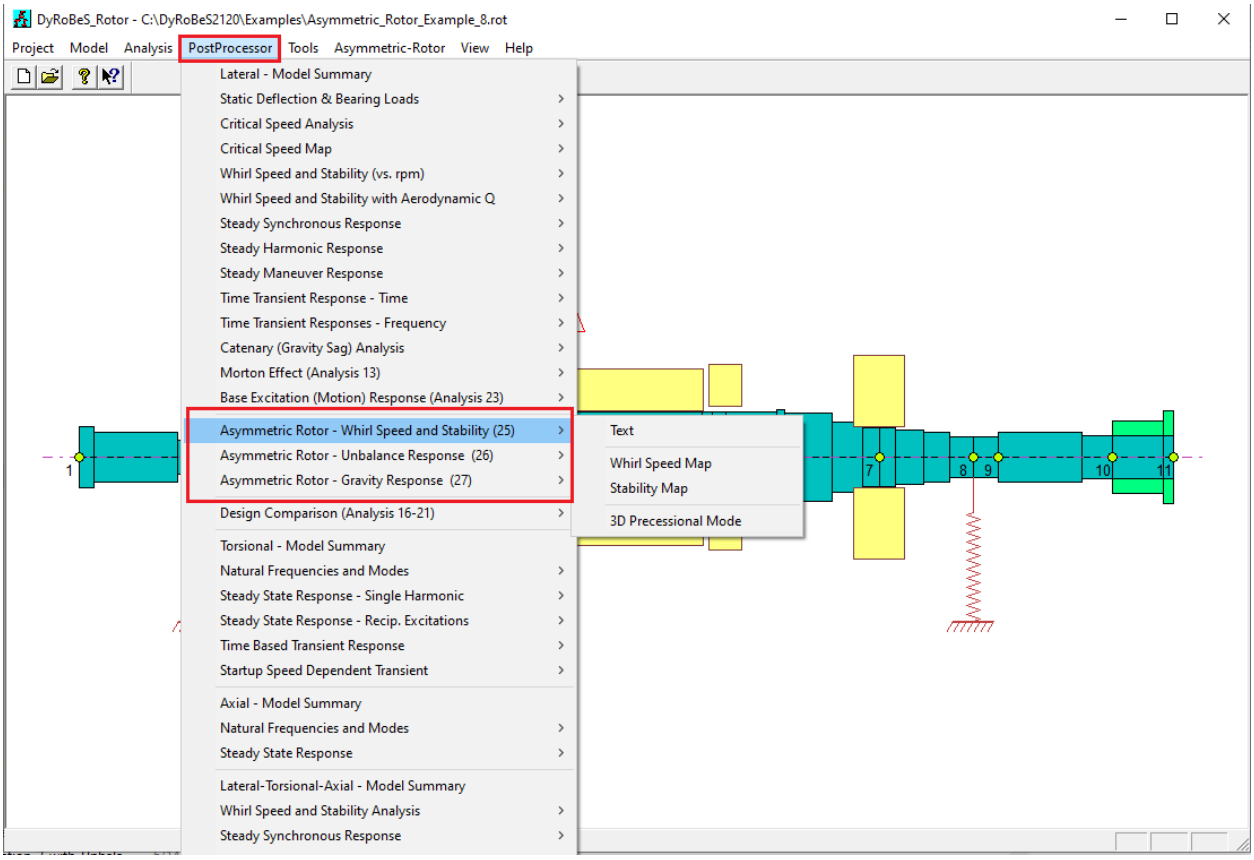
Three analyses are implemented for the asymmetric rotor system. They are Analysis 25, 26, and 27 as shown below.



## PostProcessor

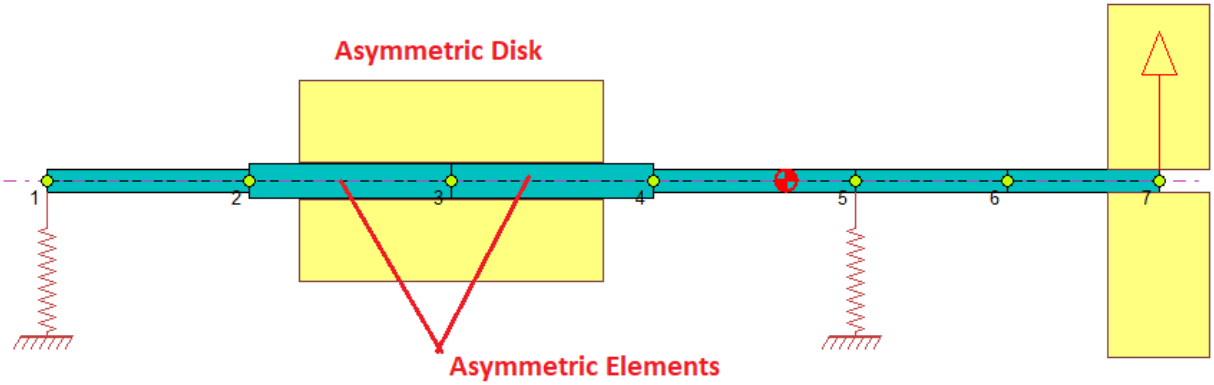
The results can be viewed from the PostProcessor options as shown below.



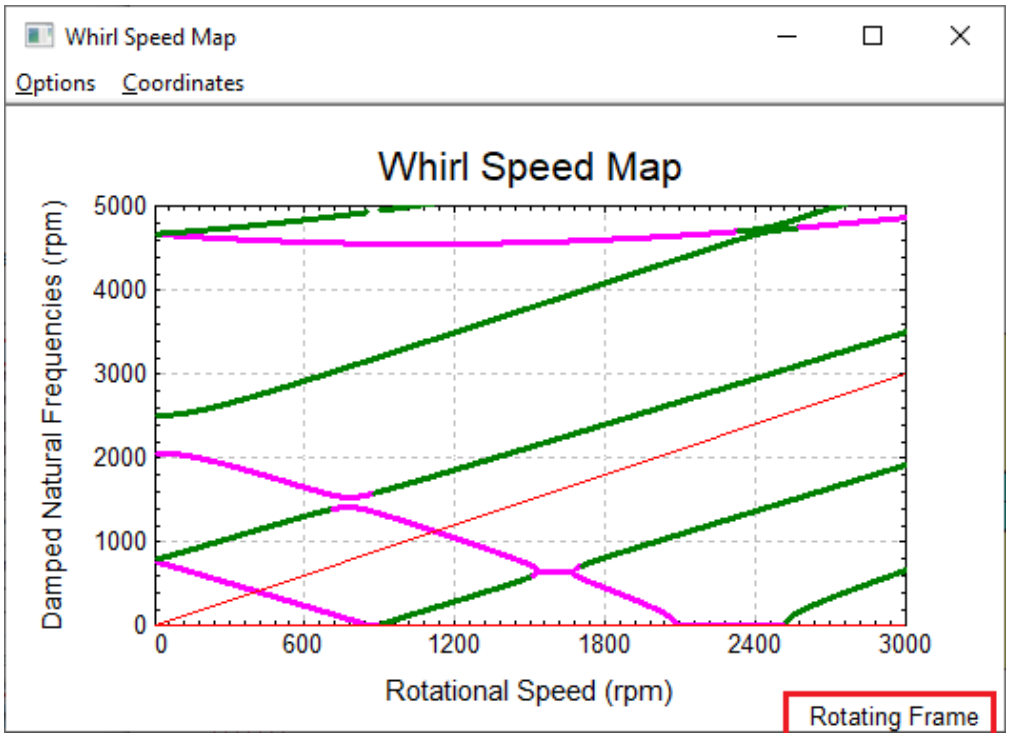

The analysis results for Examples 6, 7, and 8 are presented below.

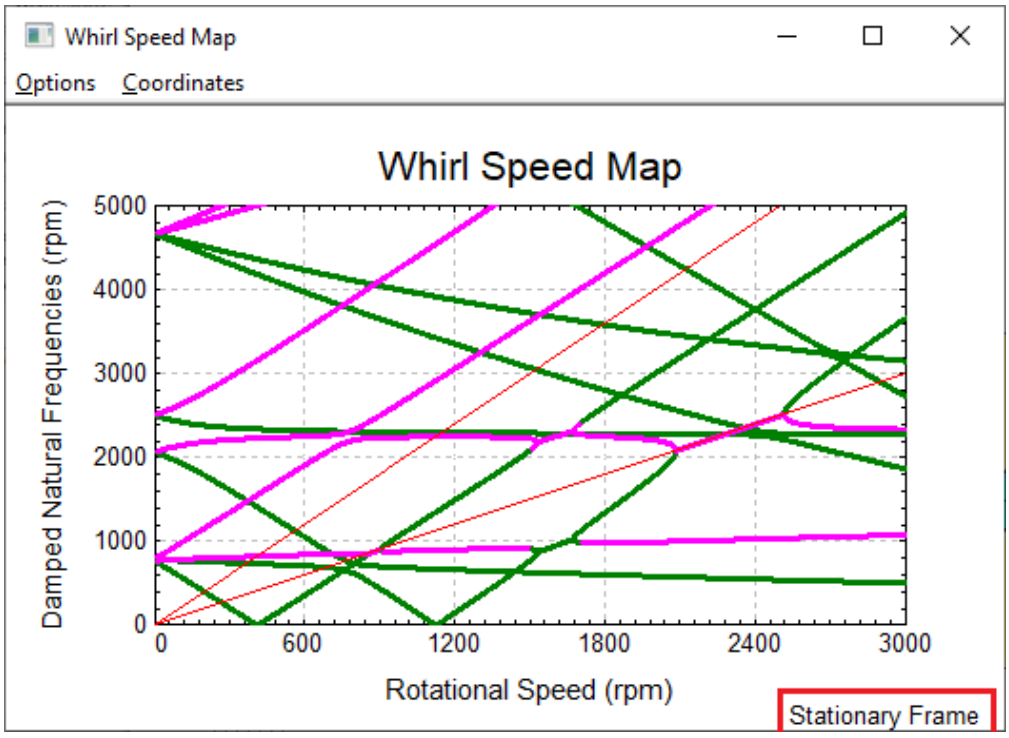
**Example 6**

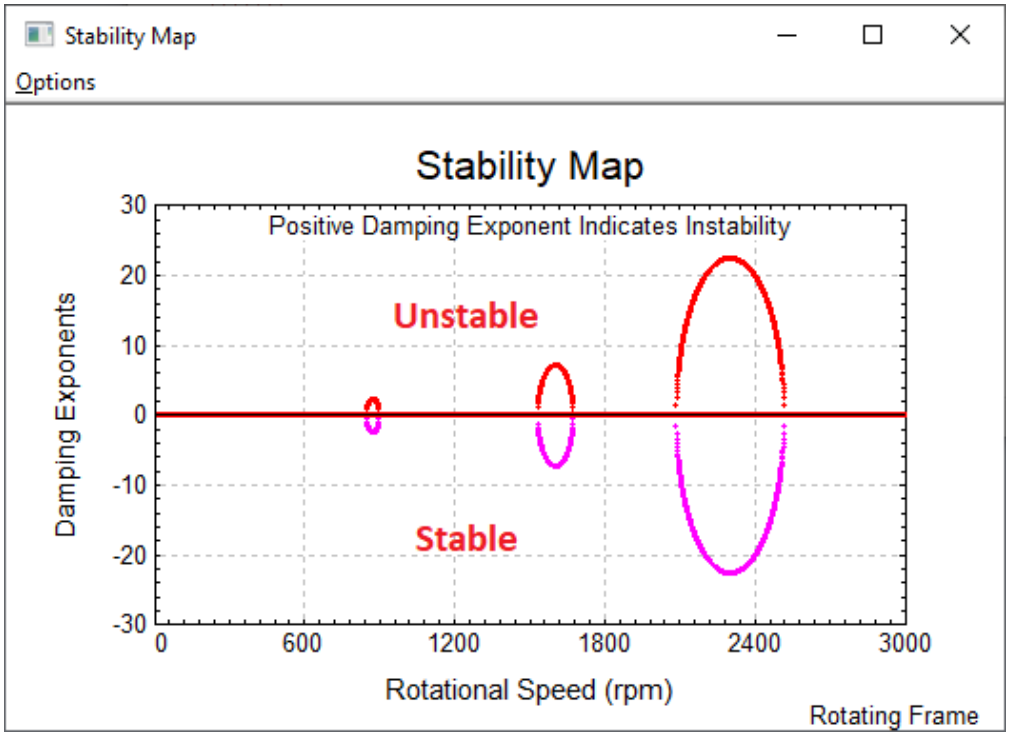
Example 6 is an overhung rotor as shown below with an asymmetric disk and two asymmetric shaft elements.



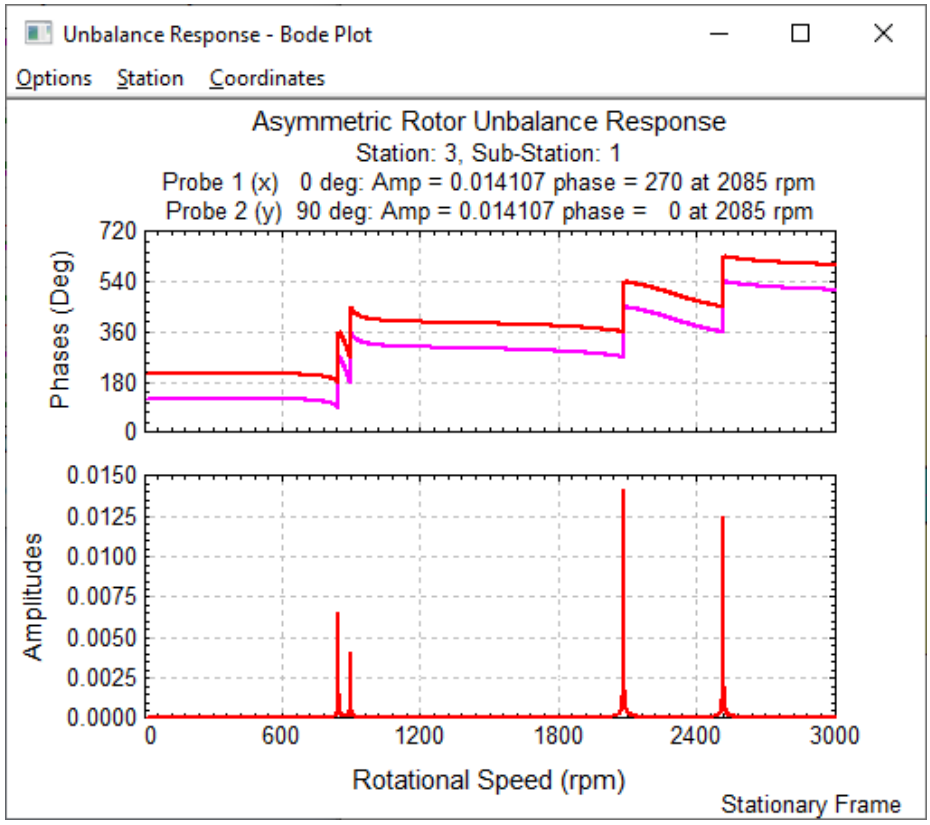

Whirl Speed Map in both rotating and fixed reference frame and stability map in the rotating frame:

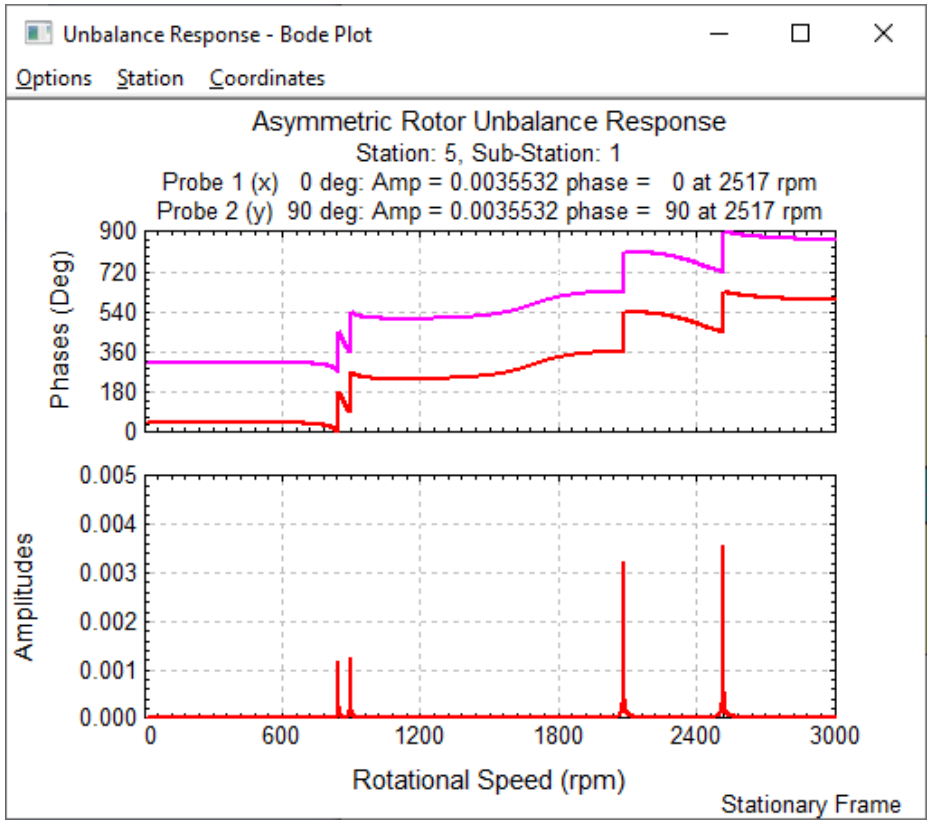


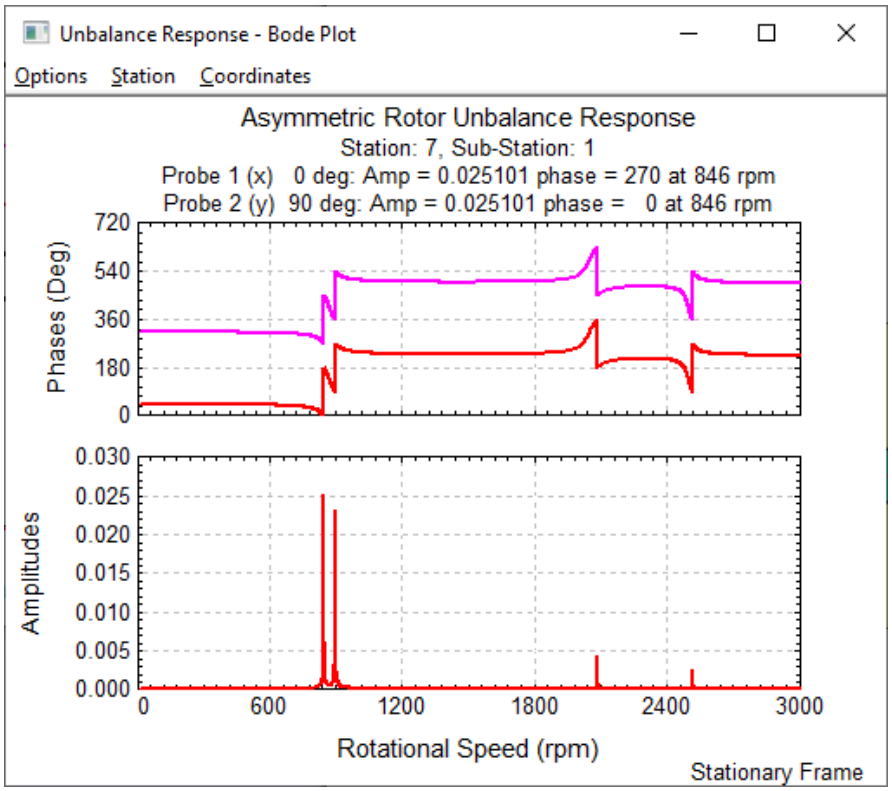


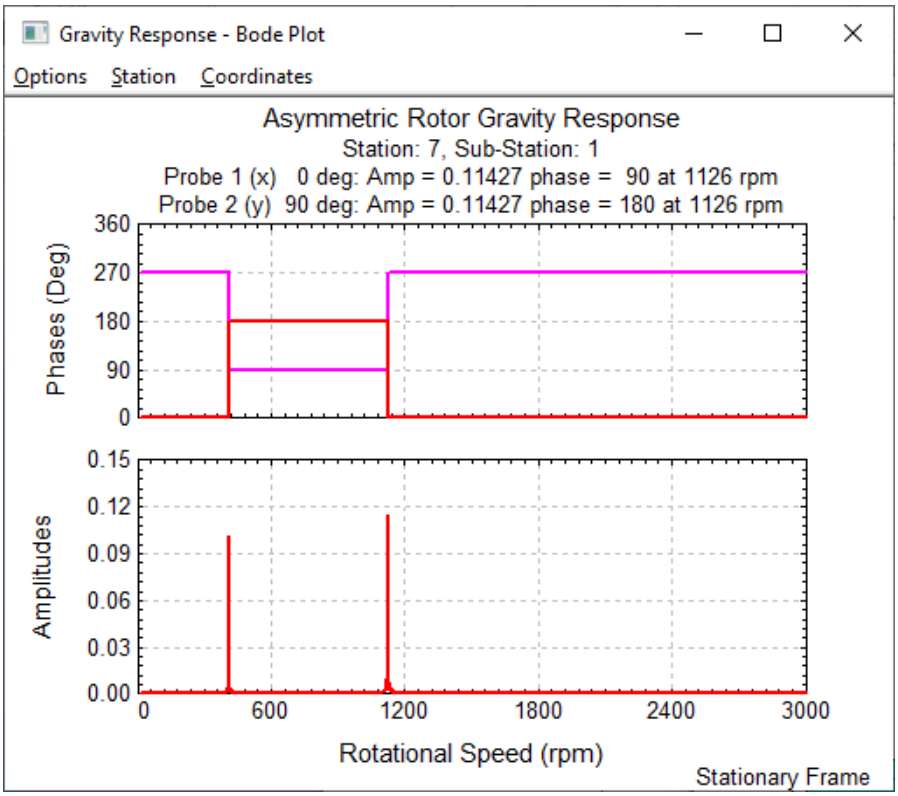

Unbalance Responses at stations 3, 5, and 7.


Unbalance Response - Bode Plot
Options Station Coordinates
Asymmetric Rotor Unbalance Response
Station: 3, Sub-Station: 1
Probe 1 (x) 0 deg: Amp = 0.014107 phase = 270 at 2085 rpm
Probe 2 (y) 90 deg: Amp = 0.014107 phase = 0 at 2085 rpm
Phases (Deg)
720
540
360
180
0
Amplitudes
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0
600
1200
1800
2400
3000
Rotational Speed (rpm)
Stationary Frame


Unbalance Response - Bode Plot
Options Station Coordinates
Asymmetric Rotor Unbalance Response
Station: 5, Sub-Station: 1
Probe 1 (x) 0 deg: Amp = 0.0035532 phase = 0 at 2517 rpm
Probe 2 (y) 90 deg: Amp = 0.0035532 phase = 90 at 2517 rpm
Phases (Deg)
900
720
540
360
180
0
Amplitudes
0.005
0.004
0.003
0.002
0.001
0.000
0
600
1200
1800
2400
3000
Rotational Speed (rpm)
Stationary Frame

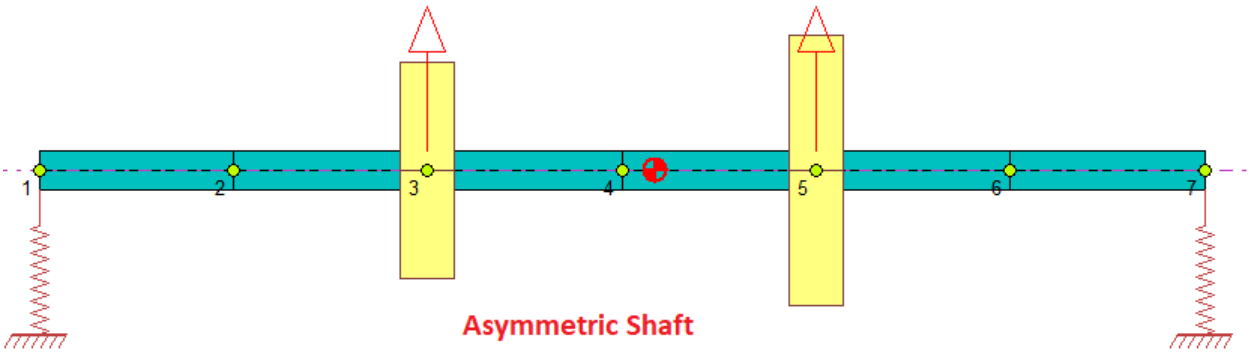



Gravity Response at station 7

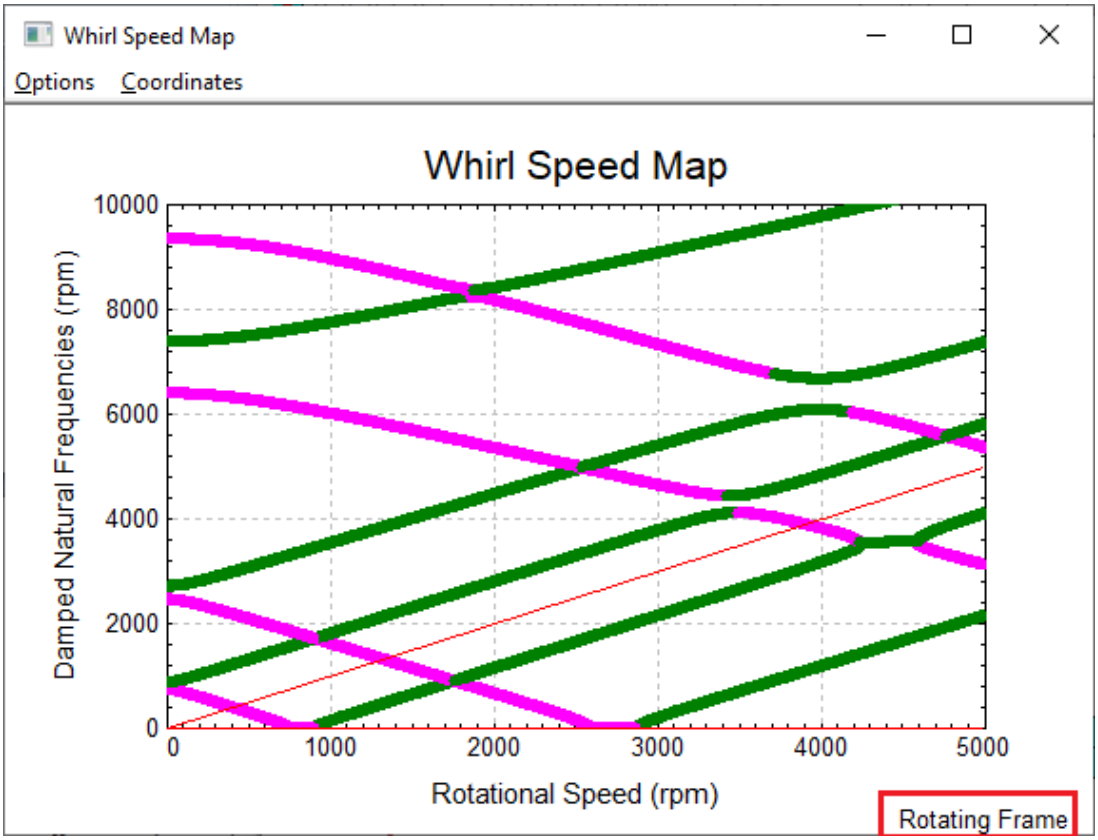


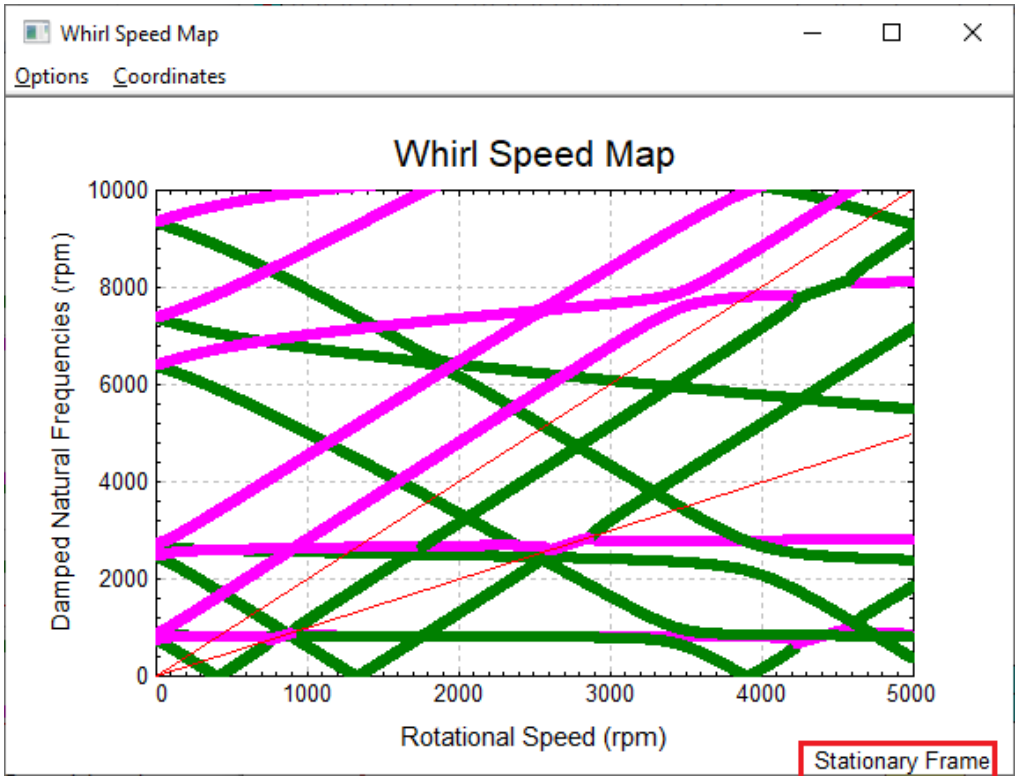
**Example 7**

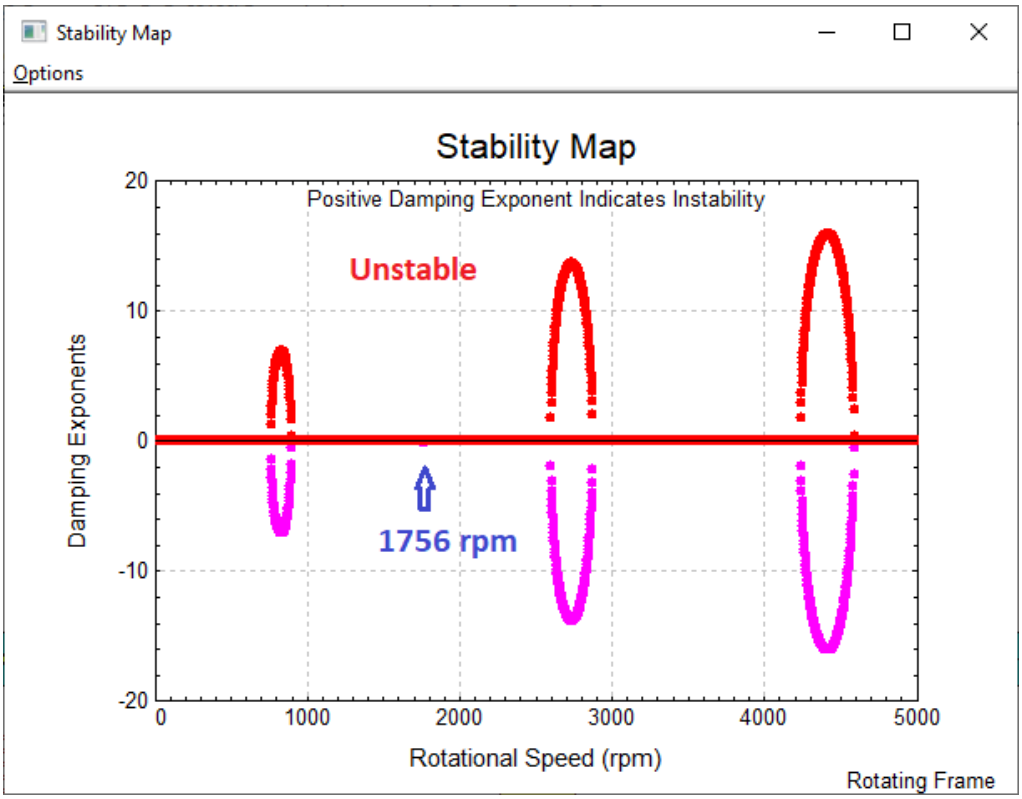
Example 7 is a two- symmetric- disks mounted on an asymmetric shaft system taken from Friswell's book. Note that in Friswell's book, only the stiffness matrix is considered to be asymmetric, the mass/inertia matrix is still assumed to be symmetric. In DyRoBeS, both the stiffness and mass/inertia matrices are modeled as asymmetric.




Whirl Speed Map and stability map:

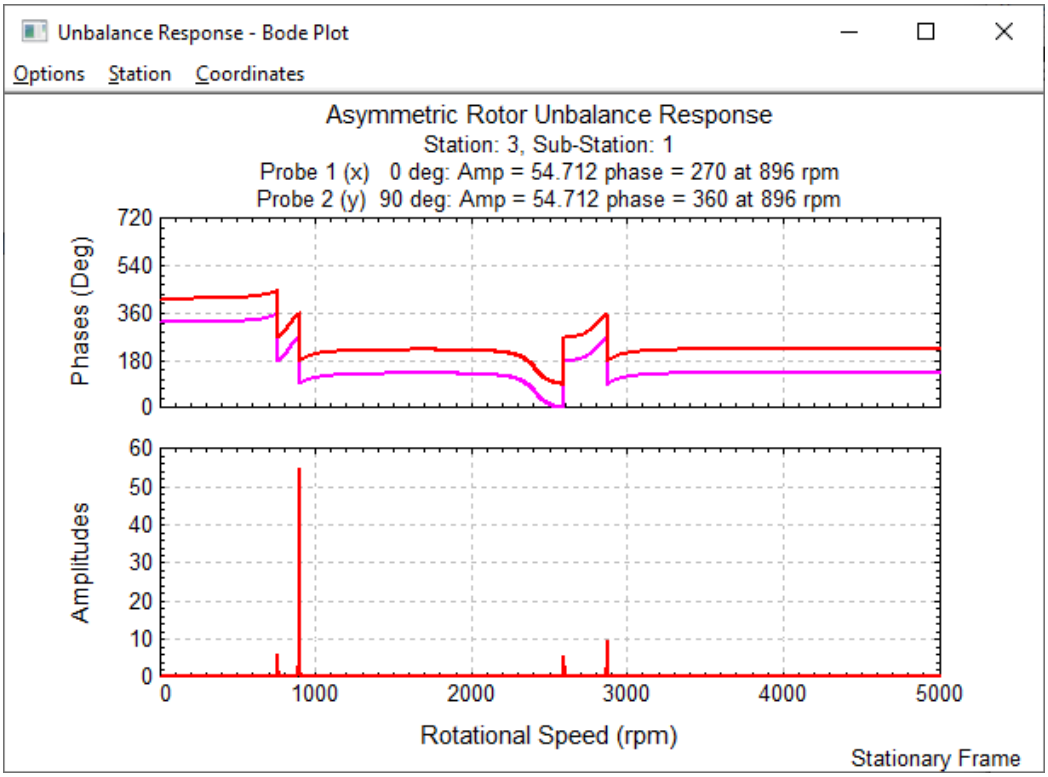


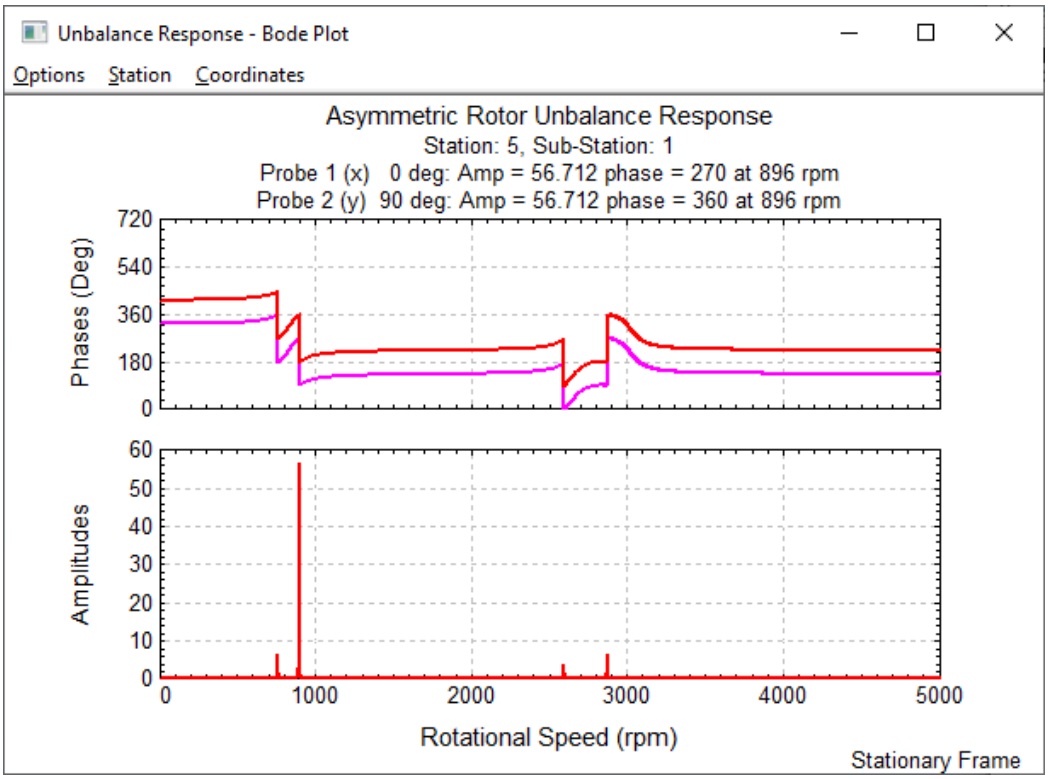


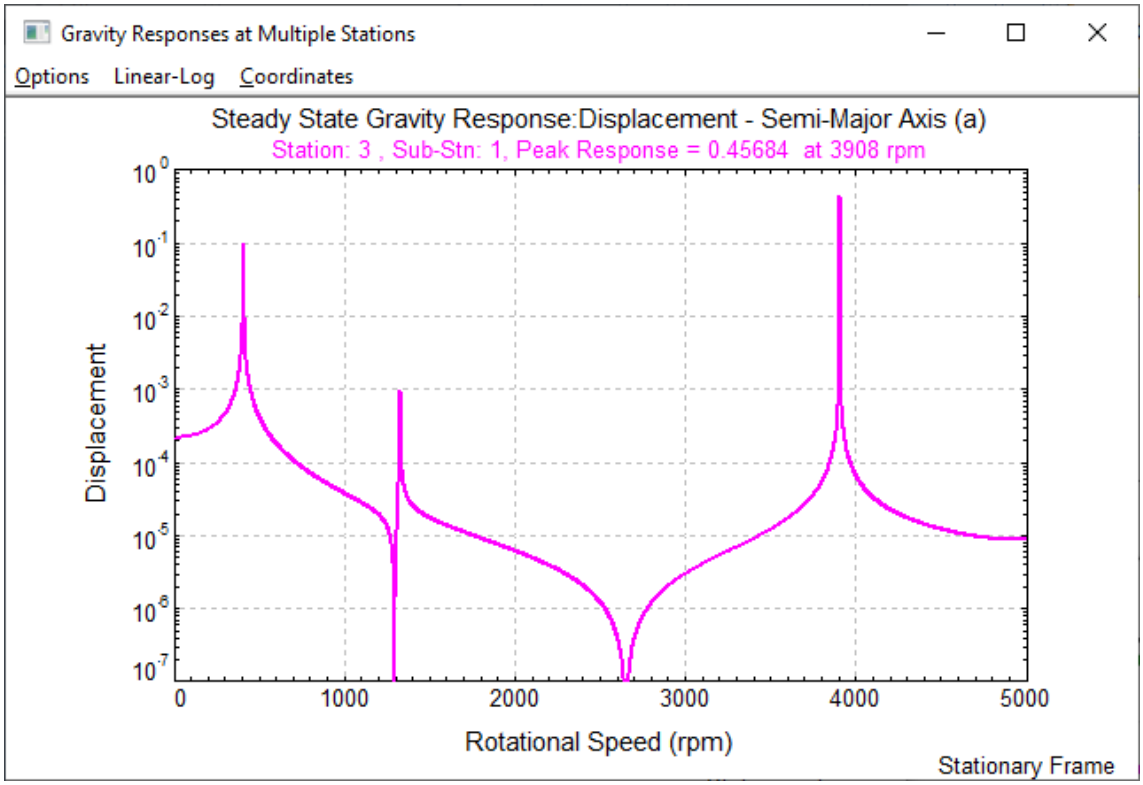

Note that there are four unstable zones. The one at 1756 rpm has very small range.

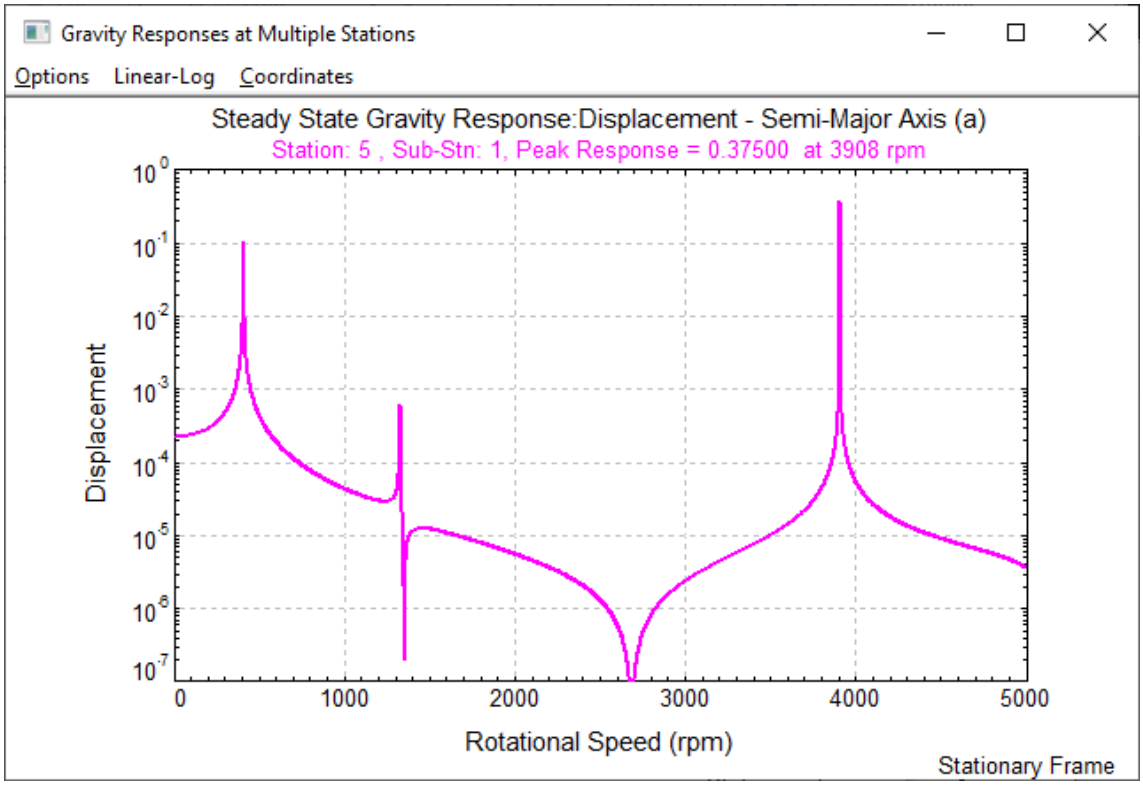
Unbalance responses at stations 3 and 5.



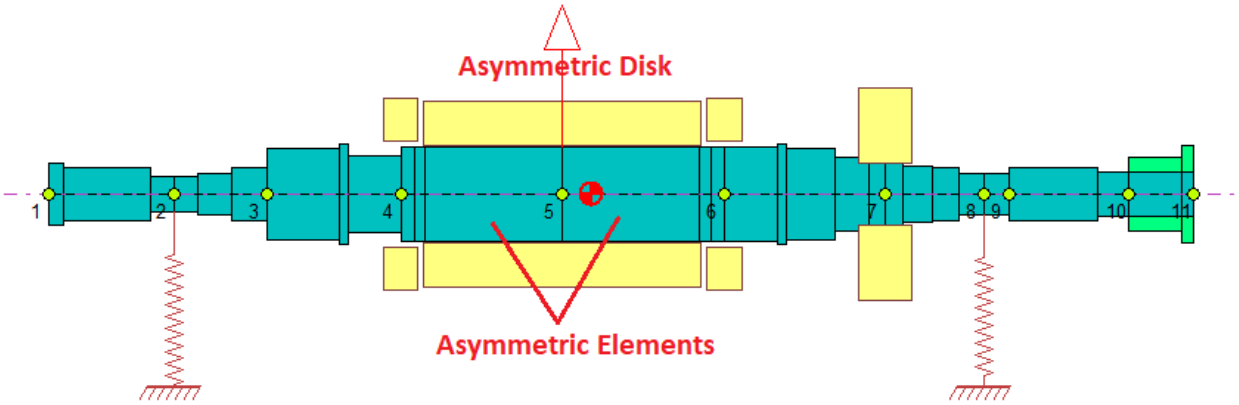
Gravity responses at stations 3 and 5.



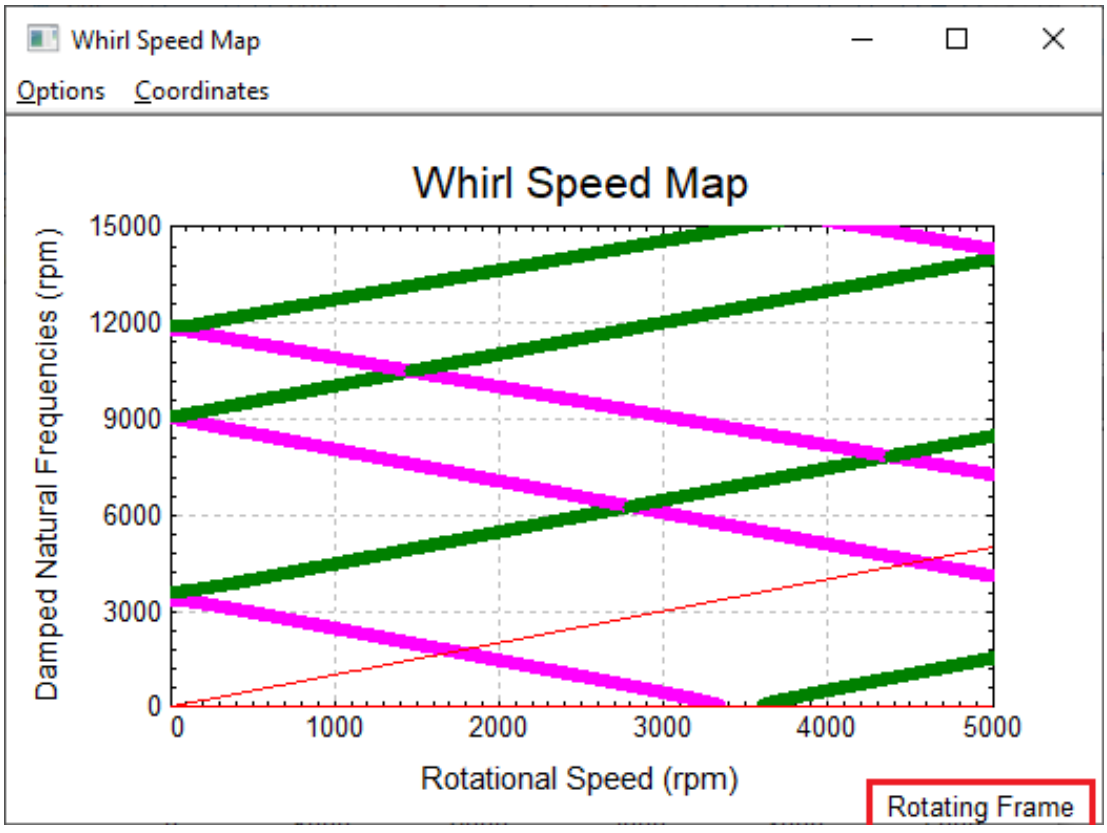



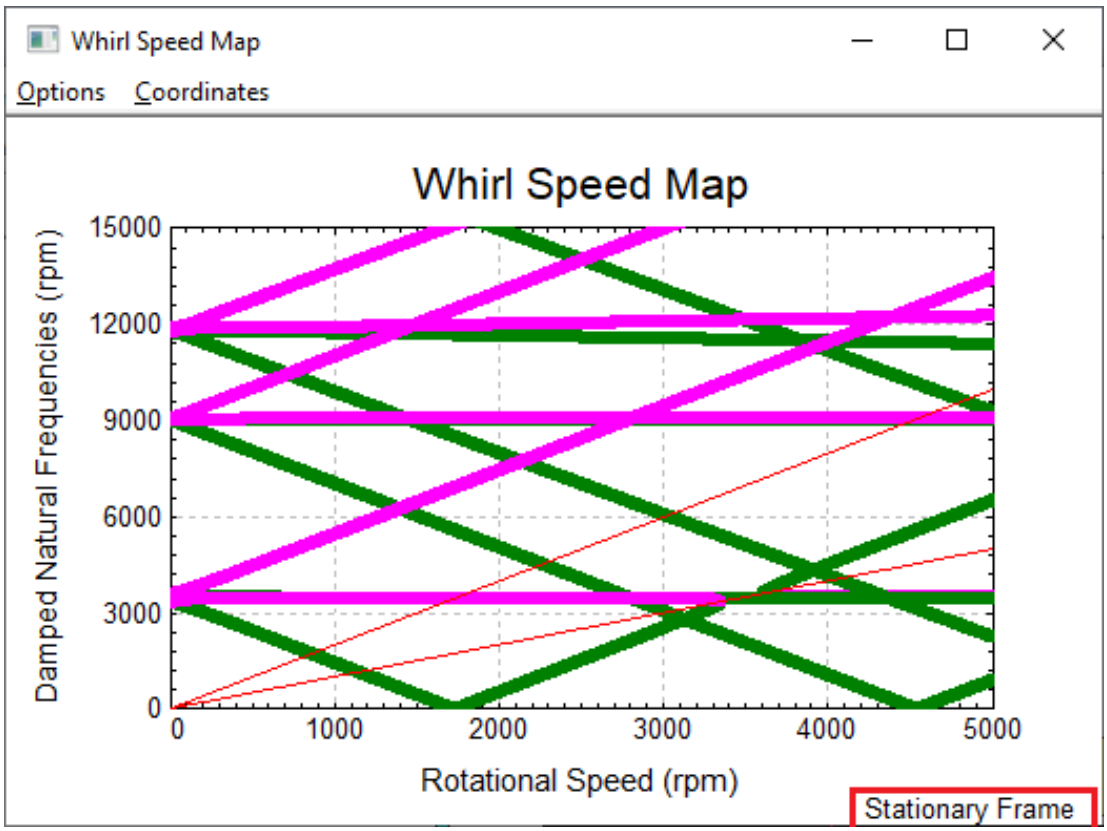
**Example 8**

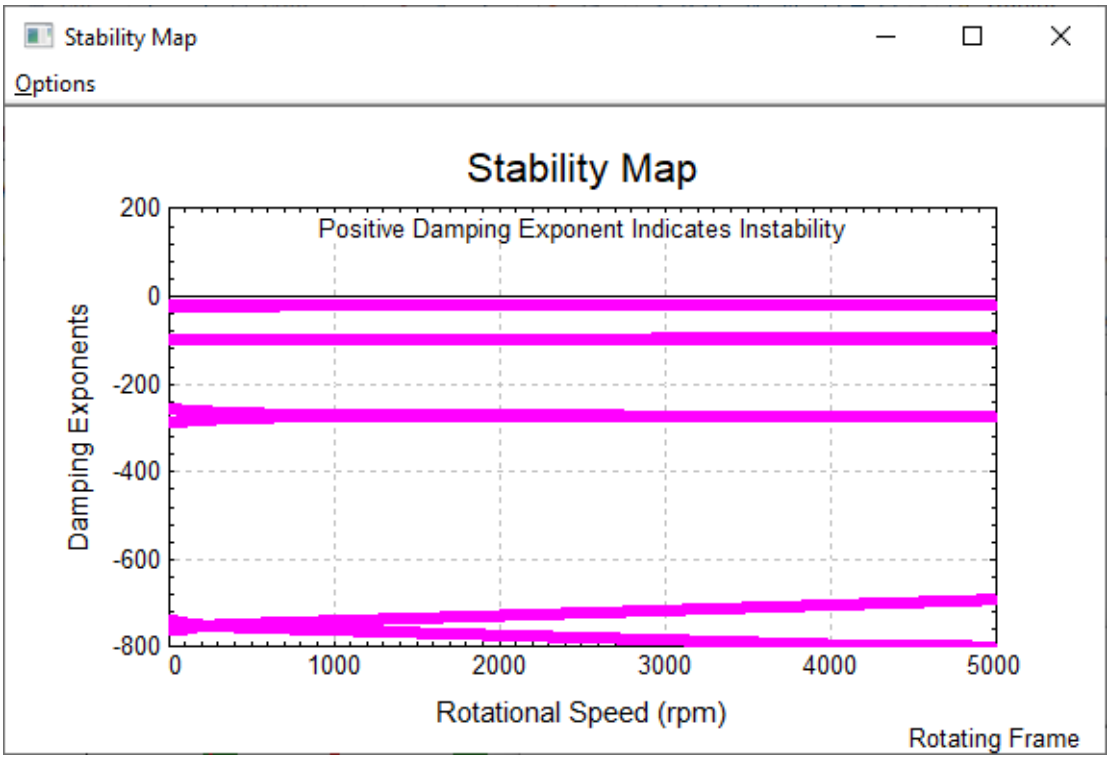
Example 8 is a 925KW-50Hz induction motor.




Whirl Speed Map and Stability Map:

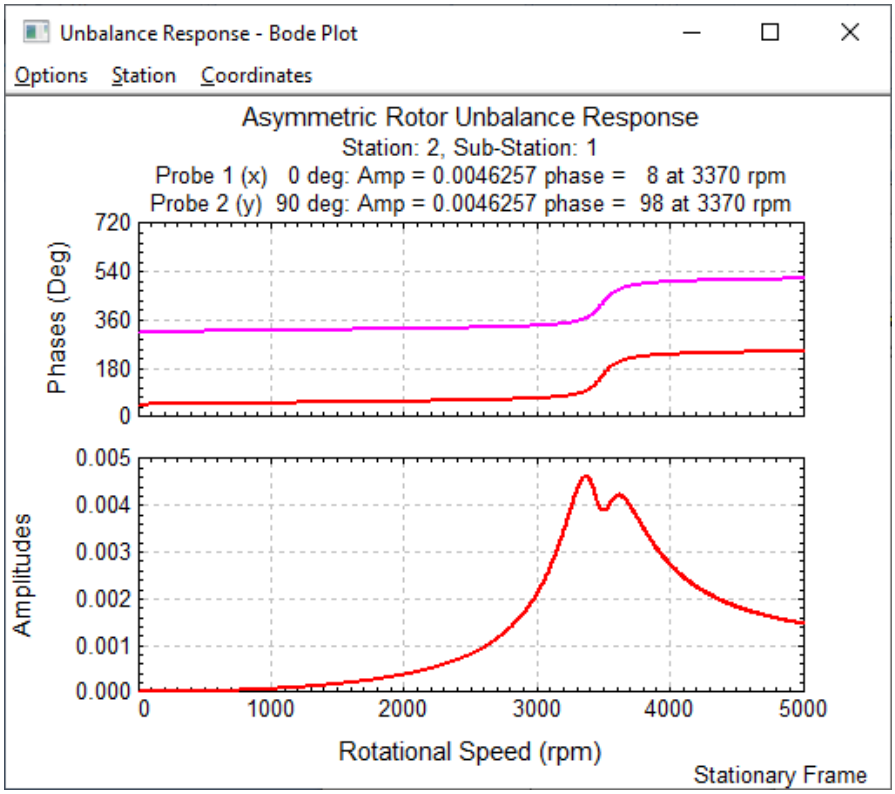


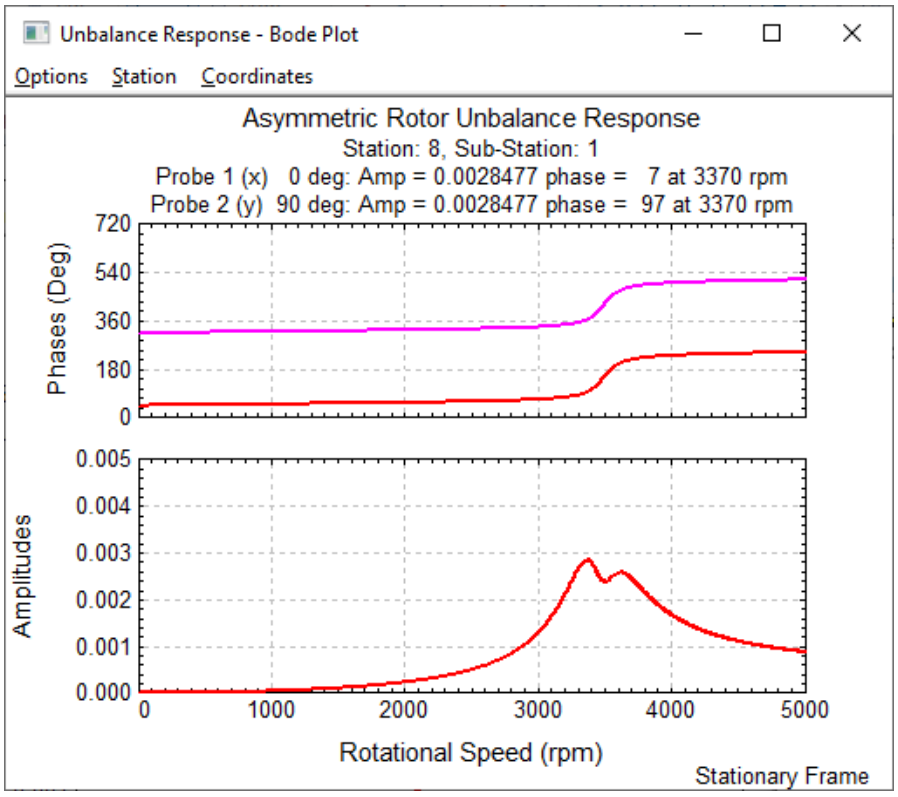
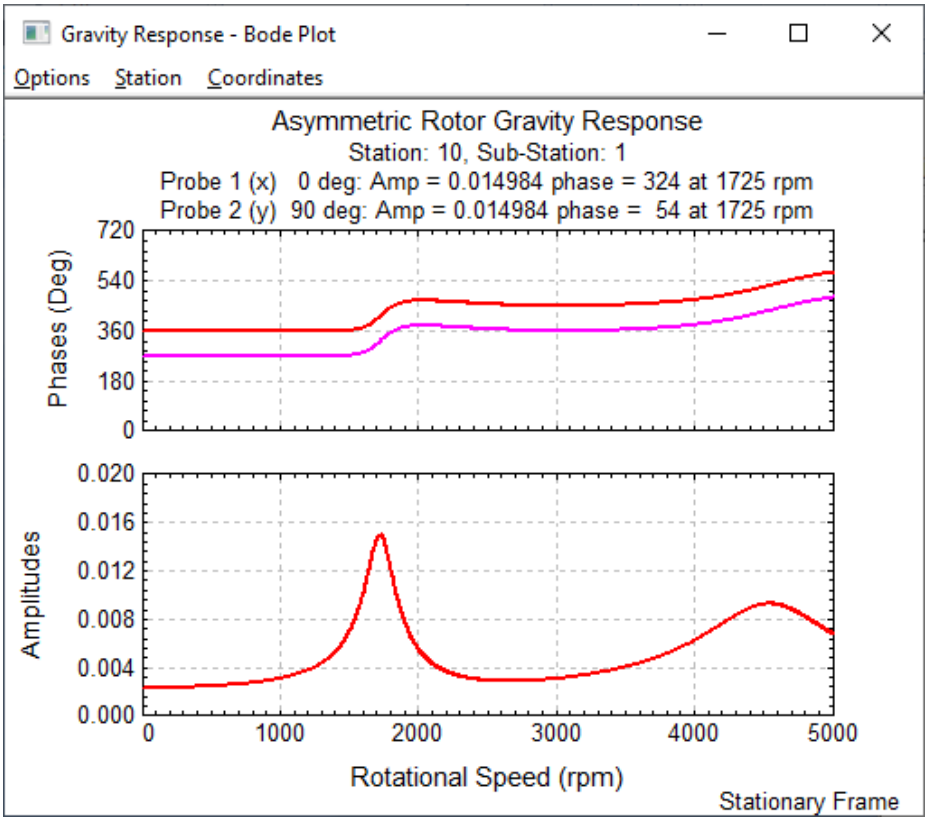
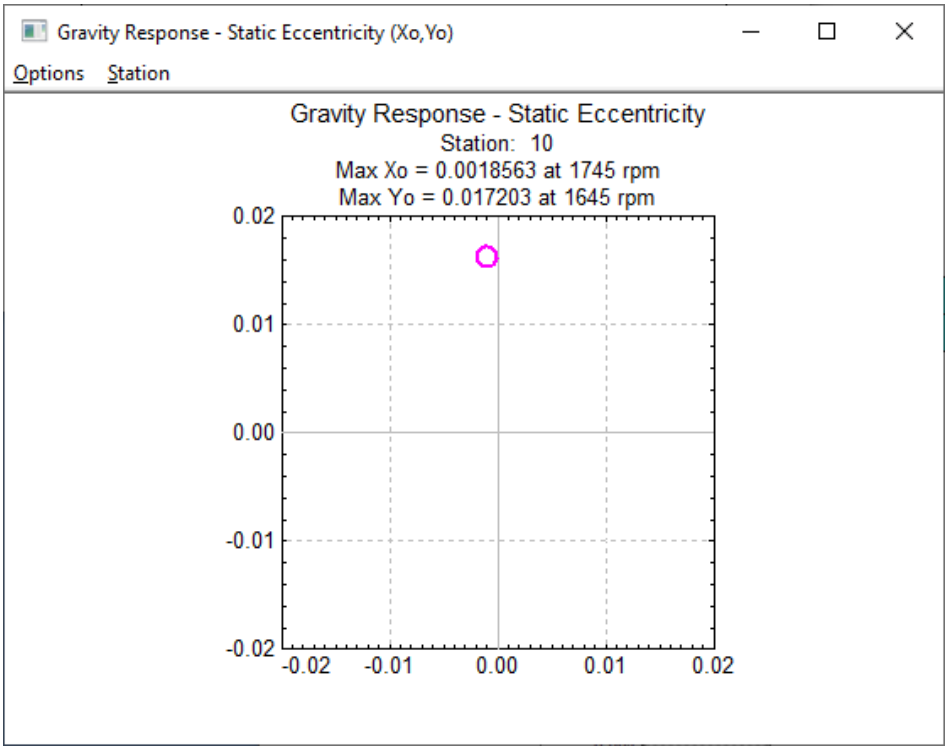



NO unstable zone due to damping in the bearings.

Unbalance responses at stations 2 and 8.






Gravity Responses at station 10.