



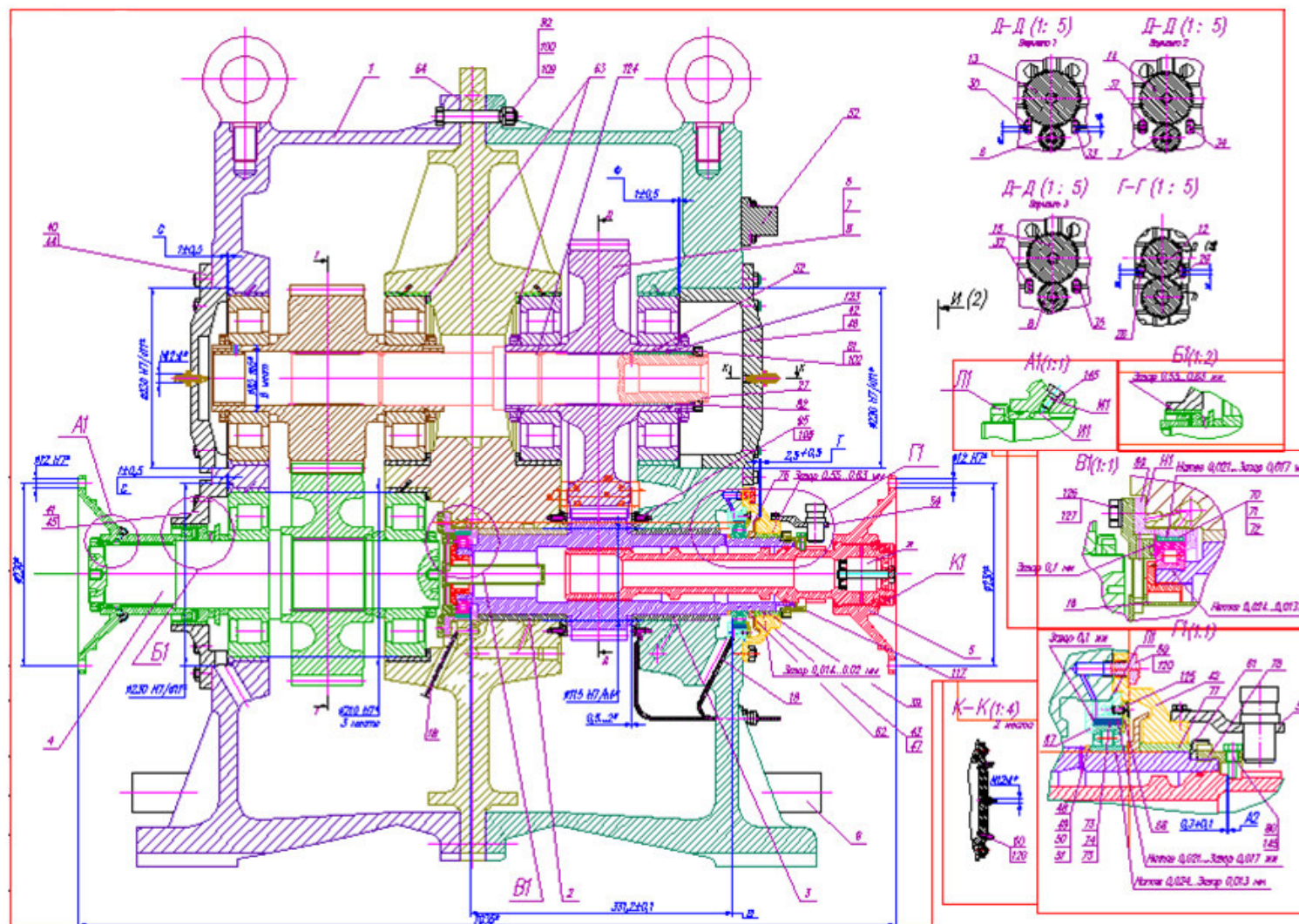
Multiplier— modeling and analysis

DYNAMICS R4

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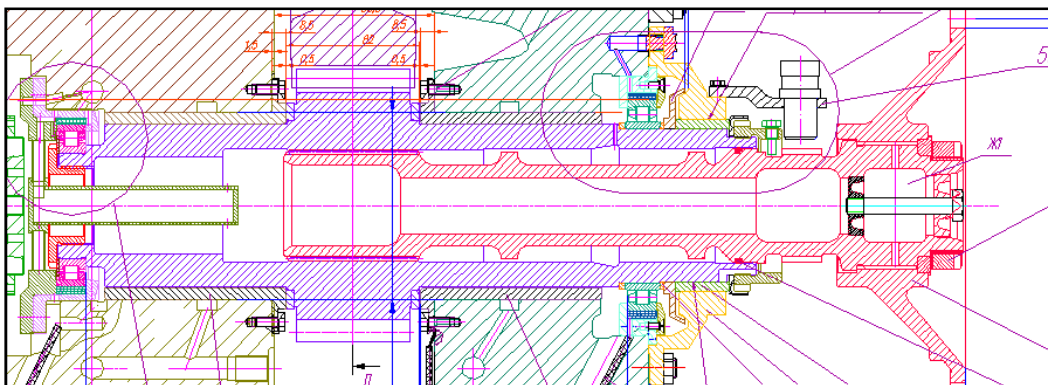
Multiplier for research



Journal bearing layout

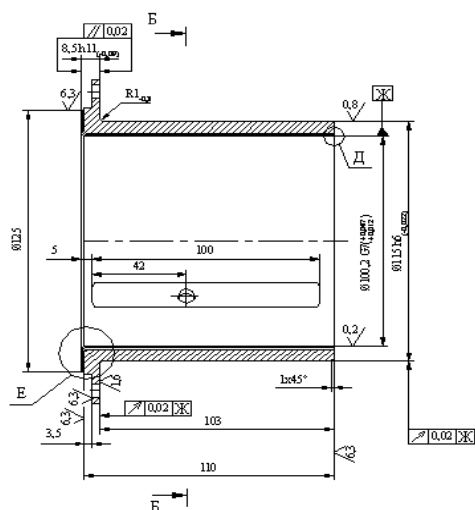


Multiplier output shaft with JB bearing



Bearing data:

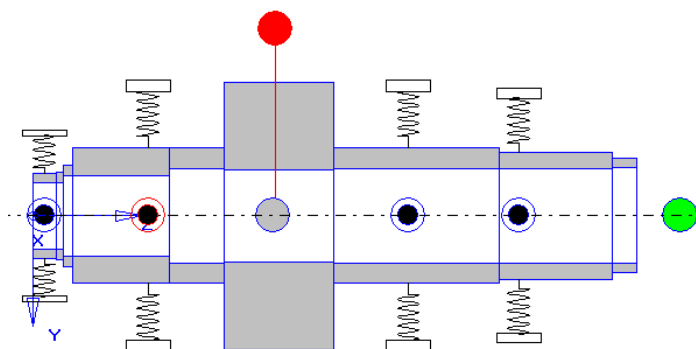
- clearance 0.12 mm
- length 109 mm,
- diameter 100 mm
- oil 5-3B, temperature 90 °C
- viscosity 0.00718 Hc/m2
- input pressure 500000 Pa



Des	Левый подшипник скольжения		Designation
conn_type	via connection point		Type of connection
side1_c_point	Левый подшипник скольжения		Side1 connection point
side2_c_point			Side2 connection point
Type	short		Design type
R	50	mm	Bearing radius
film	2pi-film		Cavitation film model
Lr	109.5	mm	Bearing length
delta	0.12	mm	Radial clearance
mue	0.0072	Ns/m2	Lubricant absolute viscosity
P0	506625	N/m2	Supply pressure to the bearing
d*	0		
D*	0		
B*	0	mm	width

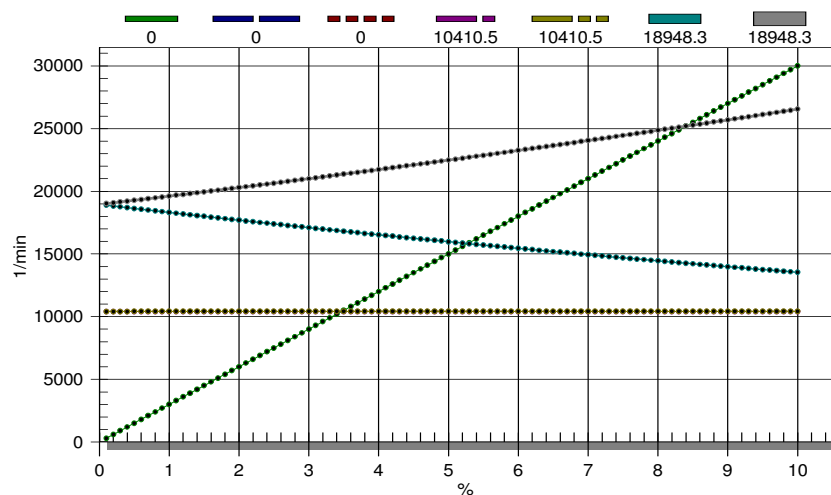
Dynamics R4 JB input data window

Output shaft model



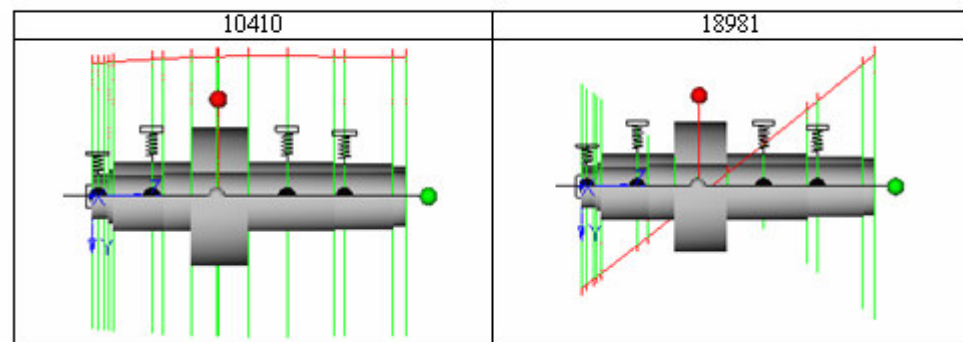
Natural frequencies map

5.2.2007 (12:16)

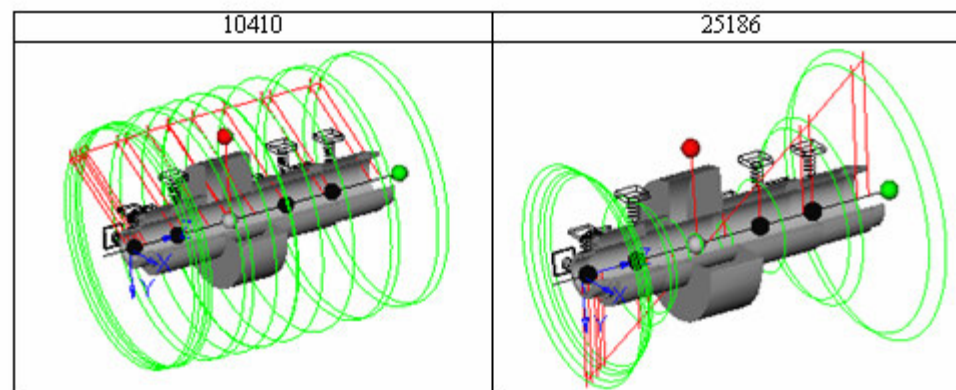


Natural frequencies of the shaft with flexible rings

Natural frequencies, rpm



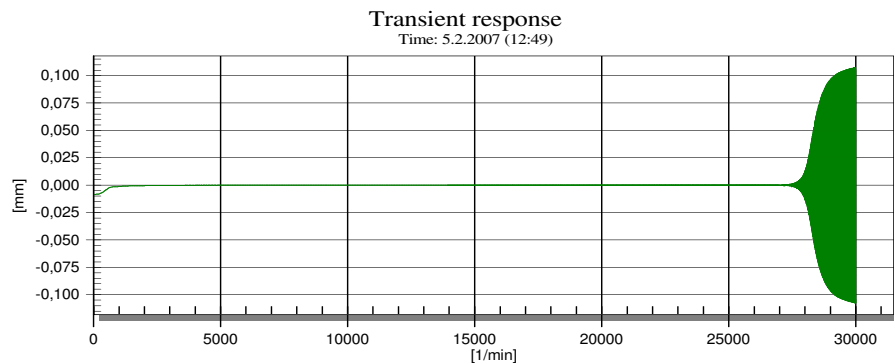
Critical speeds, rpm



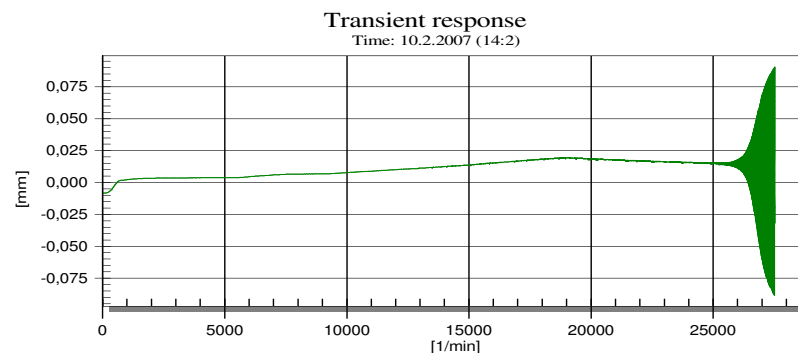
Transient response



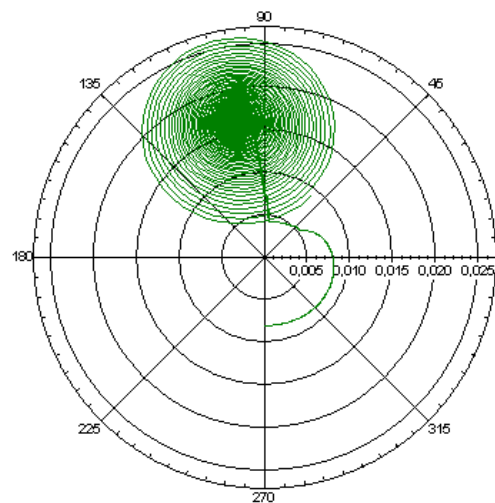
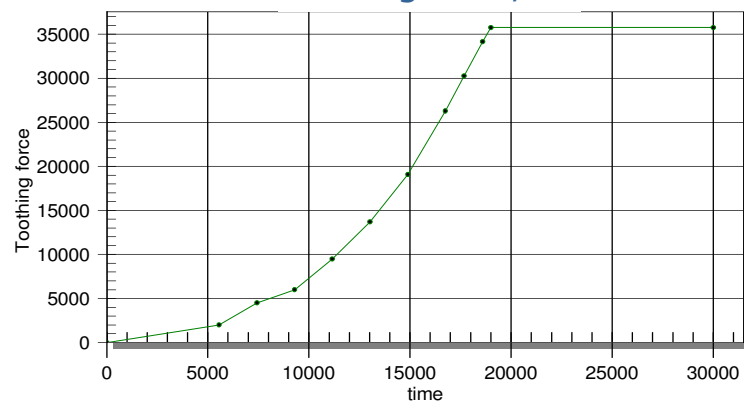
Without loading by rotational moment



With loading by rotational moment



Tooting force, N

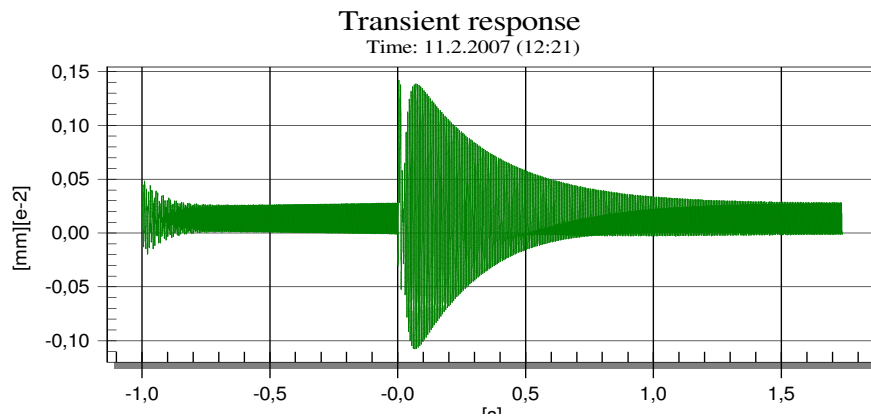


Loading influence on transient response

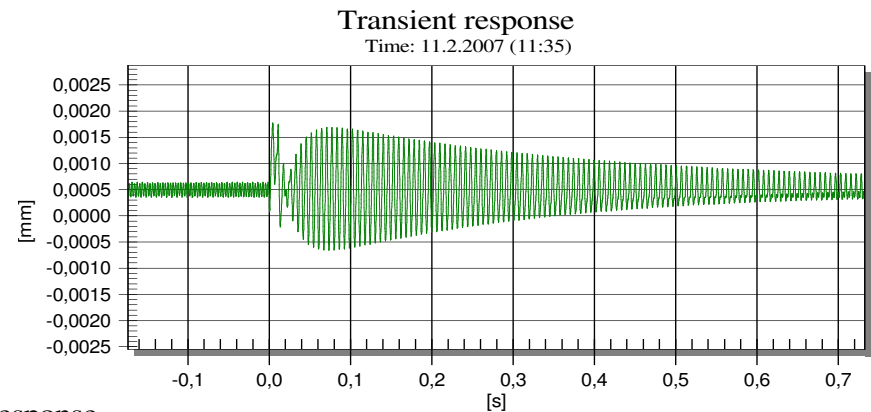


Operating speed 19000 rpm, impulse value 1400 N)

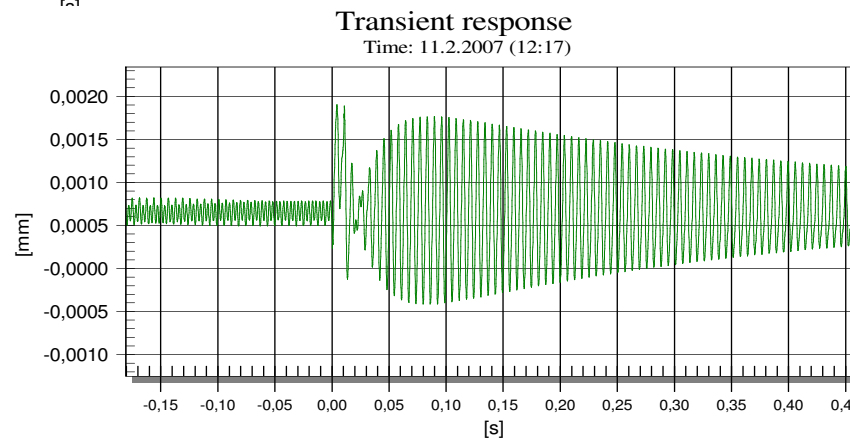
Tooting load, 0 N



Tooting load, 36000 N



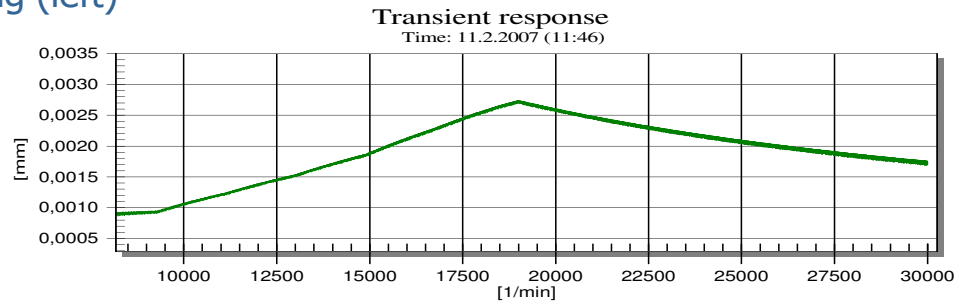
Tooting load, 60000 N



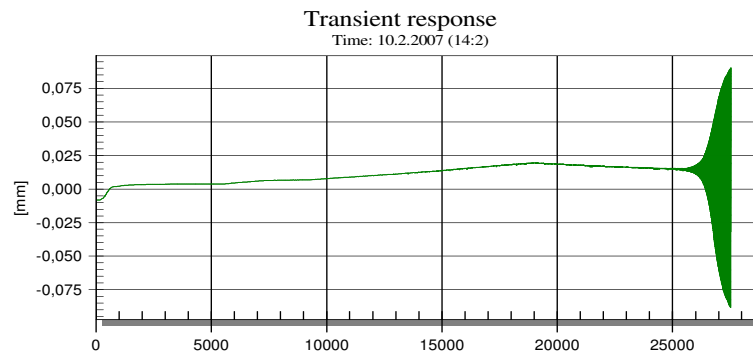
Journal bearing clearance influence on stability thresholds



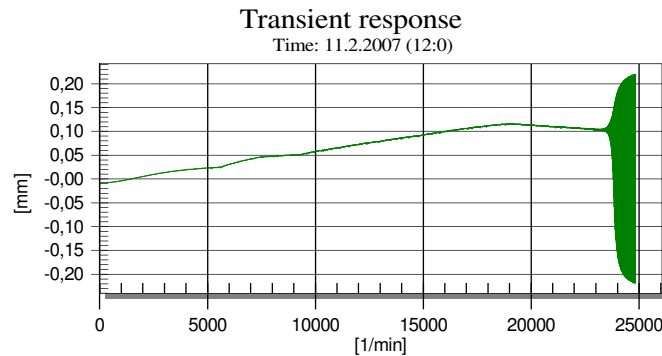
Journal bearing (left)



Clearance 0.06 mm



0.12 mm

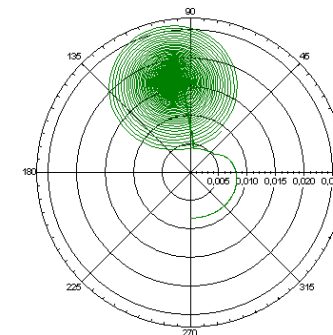
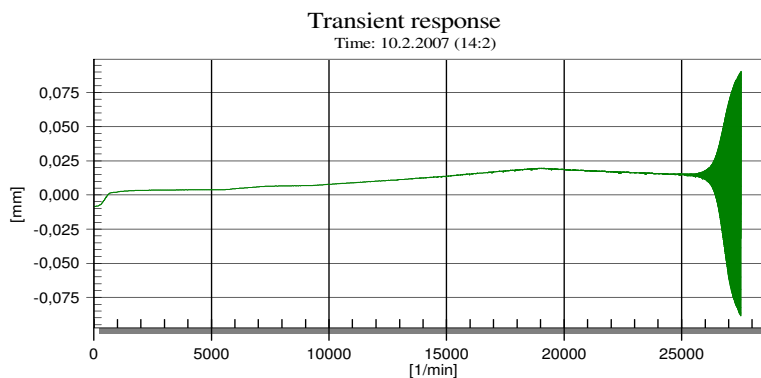
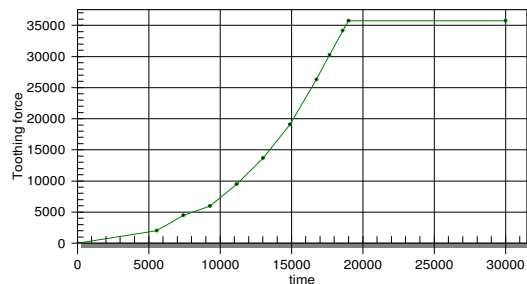


0.24 mm

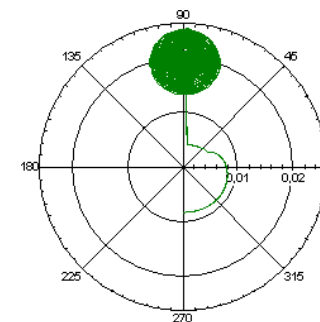
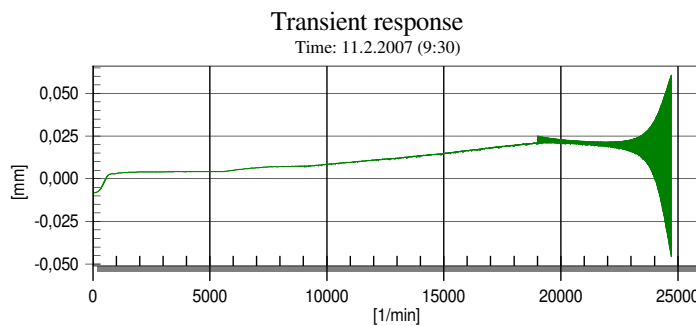
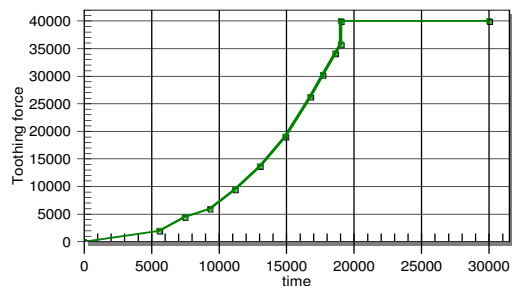
Loading influence on stability thresholds



Maximal tooting force – 36000 N



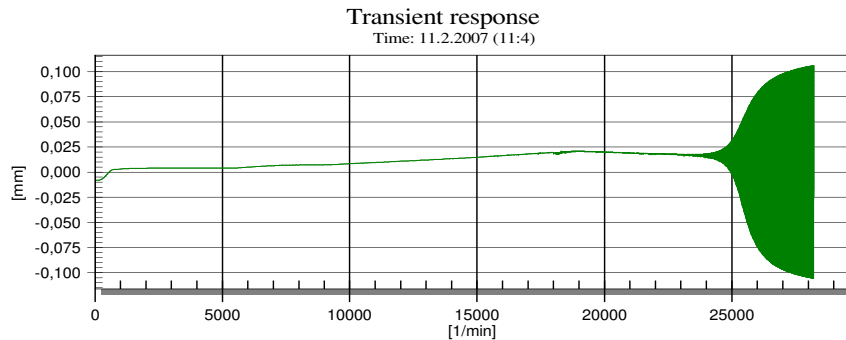
Maximal tooting force – 40000 N



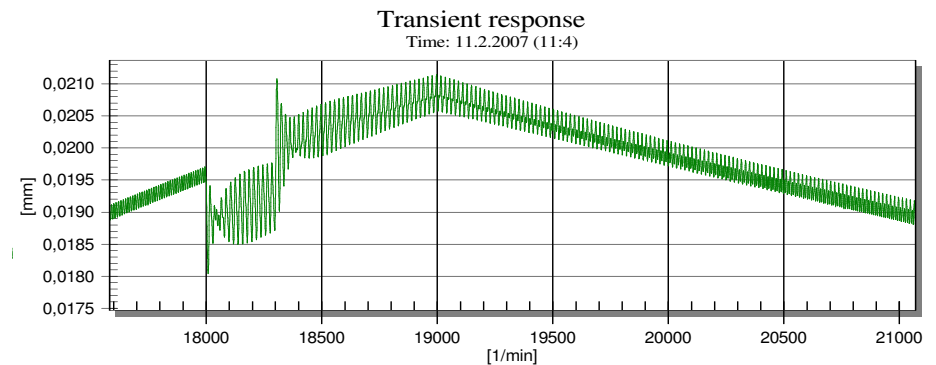
Time impulse influence on stability thresholds



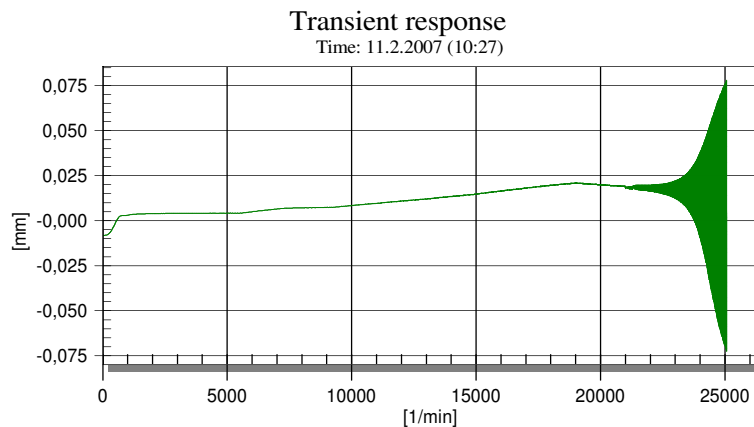
Value of impulse 140 N, time of impulse generation - 6 sec



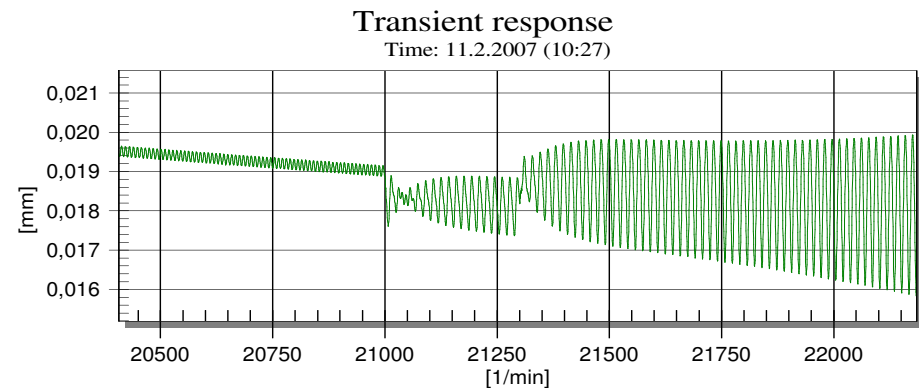
Scaled time signal



Value of impulse 140 N, time of impulse generation - 7 sec



Scaled time signal

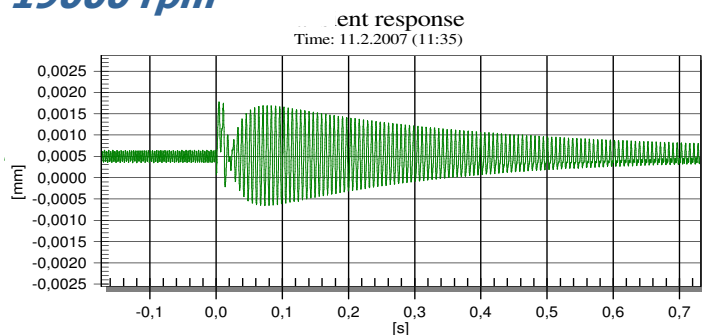


Stability analysis

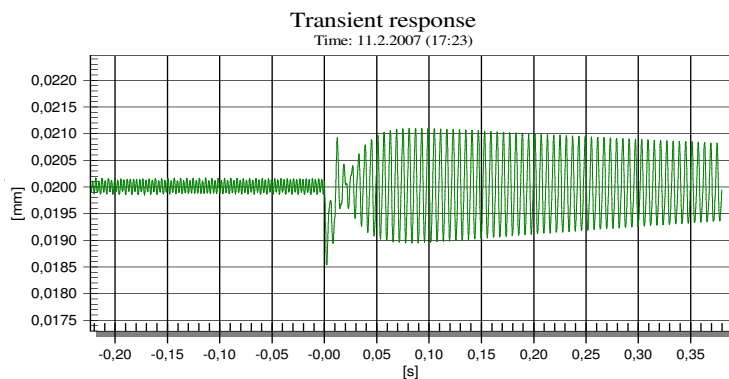


Loading 36000 N, Impulse 1400 H

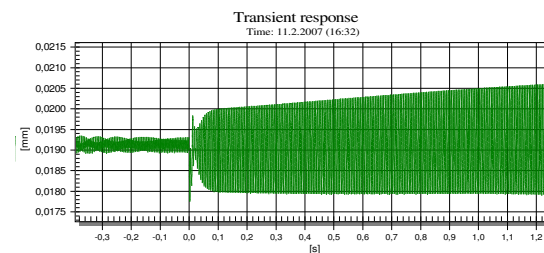
19000 rpm



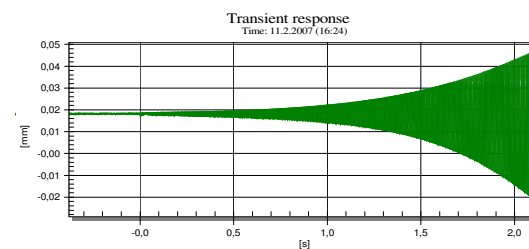
20000 rpm



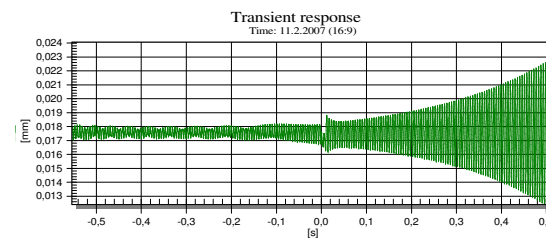
21000 rpm



22000 rpm



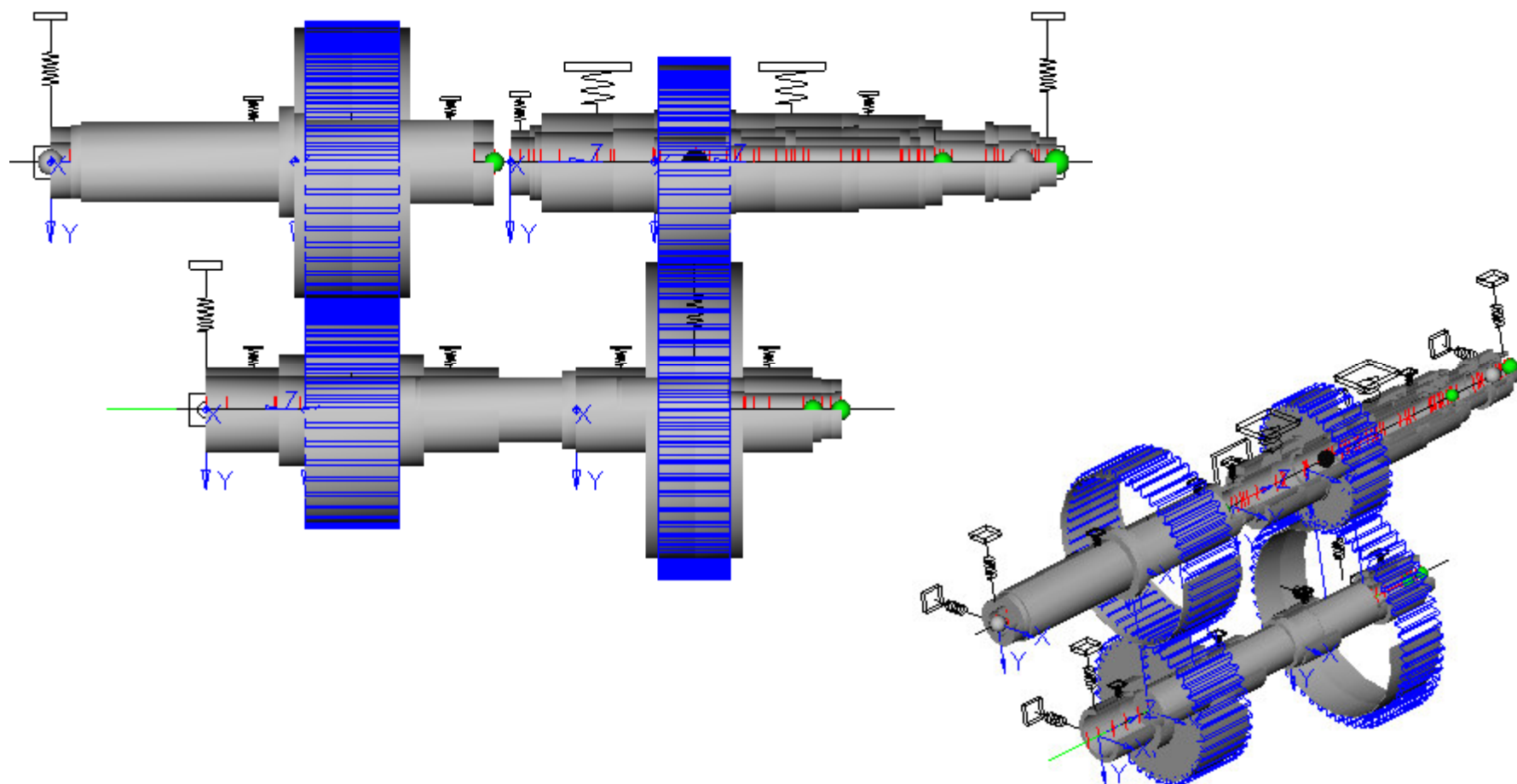
23000 rpm



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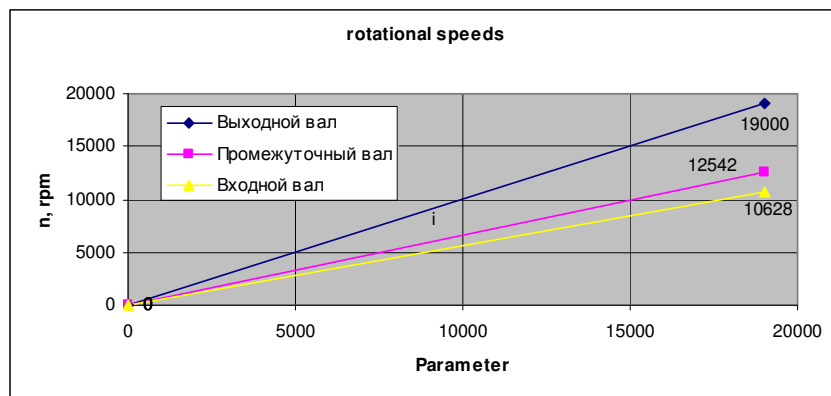
Multiplier 3D- model



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Input and output shafts rotational moments



$$M := \frac{1000 \cdot N}{\left(\frac{\pi \cdot n}{30} \right)}$$

*Journal bearing radial stiffness 16000 rpm
k1=k2=0.35e9 N/m*

$$T2 := \text{augment} \left(N, n, k_0, \frac{M}{k_0} \right)$$

	0
0	0
1	175.862
2	395.689
3	527.585
4	835.344
5	1.206·10 ³
6	1.679·10 ³
7	2.314·10 ³
8	2.665·10 ³
9	3.007·10 ³
10	3.149·10 ³

	0	1	2
0	0	0	0
1	100	5577	171
2	300	7436	385
3	500	9295	514
4	950	11154	813
5	1600	13013	1174
6	2550	14893	1635
7	3950	16742	2253
8	4800	17666	2595
9	5700	18590	2928
10	6100	19001	3066

	0
0	0
1	98.373
2	221.34
3	295.12
4	467.273
5	674.559
6	939.396
7	1.294·10 ³
8	1.491·10 ³
9	1.682·10 ³
10	1.761·10 ³

	0	1	2
0	0	0	0
1	100	5577	96
2	300	7436	216
3	500	9295	287
4	950	11154	455
5	1600	13013	657
6	2550	14893	915
7	3950	16742	1260
8	4800	17666	1451
9	5700	18590	1638
10	6100	19001	1715

Analysis results

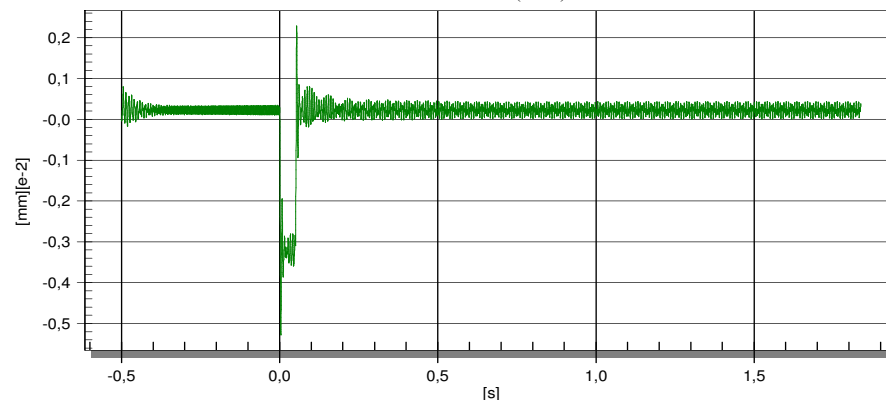


Boundary conditions (input and output shafts)

Parameter	Variant	
	1	2
<u>UT_x</u>	fixed	free
<u>UT_y</u>	fixed	free
<u>UT_z</u>	fixed	free
<u>UR_x</u>	fixed	free
<u>UR_y</u>	fixed	free
<u>UR_z</u>	fixed	free
	0.0 (0.0) — 9062.6 (151.0) 16891.1 (281.5) 32018.6 (533.6)	0.0 (0.0) — 0.0 (0.0) — 0.0 (0.0) — 0.0 (0.0) / 11544.0 (192.4) 15139.7 (252.3) 15172.3 (252.9) 27750.0 (462.5) 28261.8 (471.0) 31285.5 (521.4)

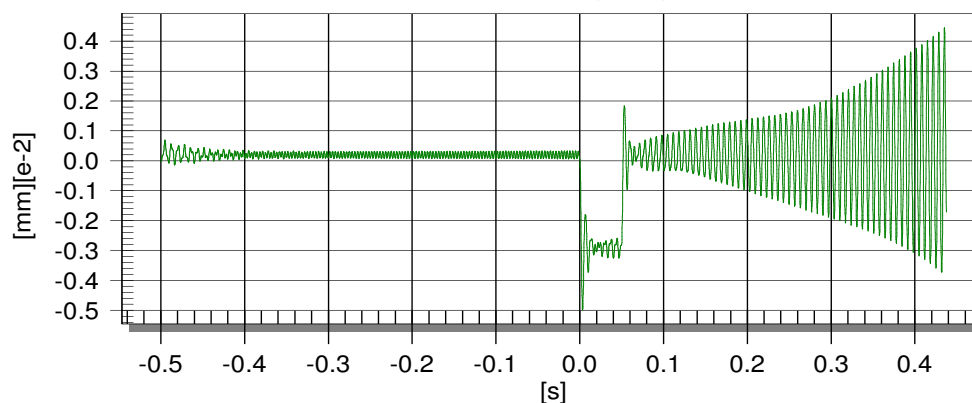
Variant 1. Operating speed 16000 rpm

Transient response
Time: 19.2.2007 (15:23)



Variant 1. Operating speed 18000 об/мин

Transient response
Time: 19.2.2007 (21:12)



Multilevel rotor structure with the gear transmission

