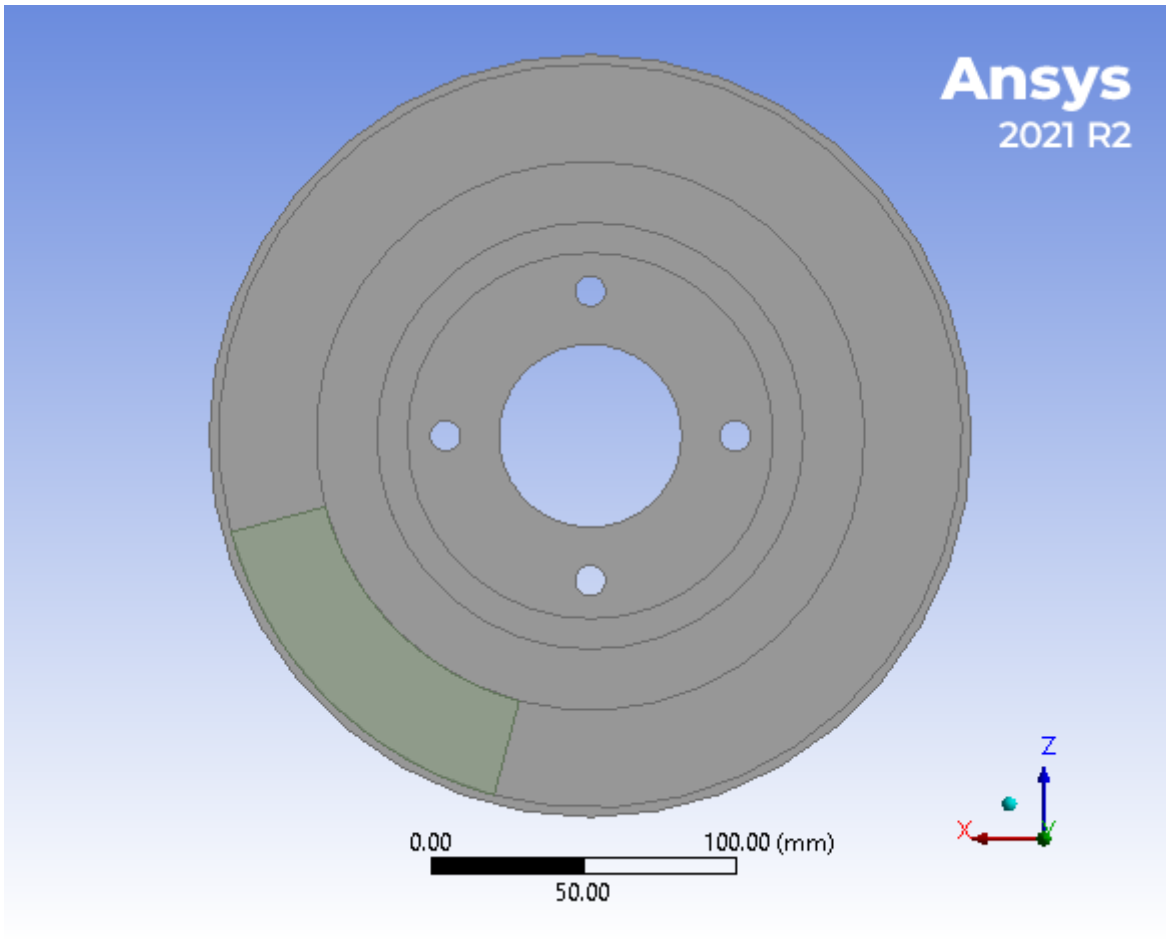
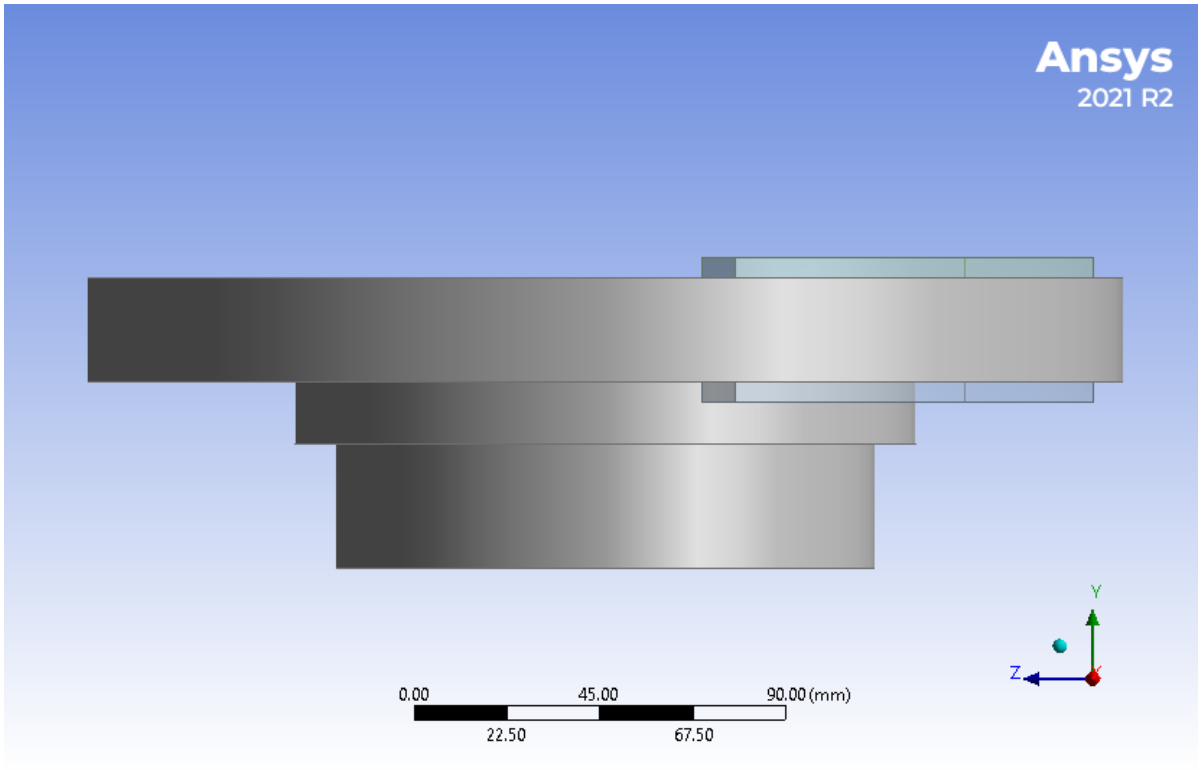
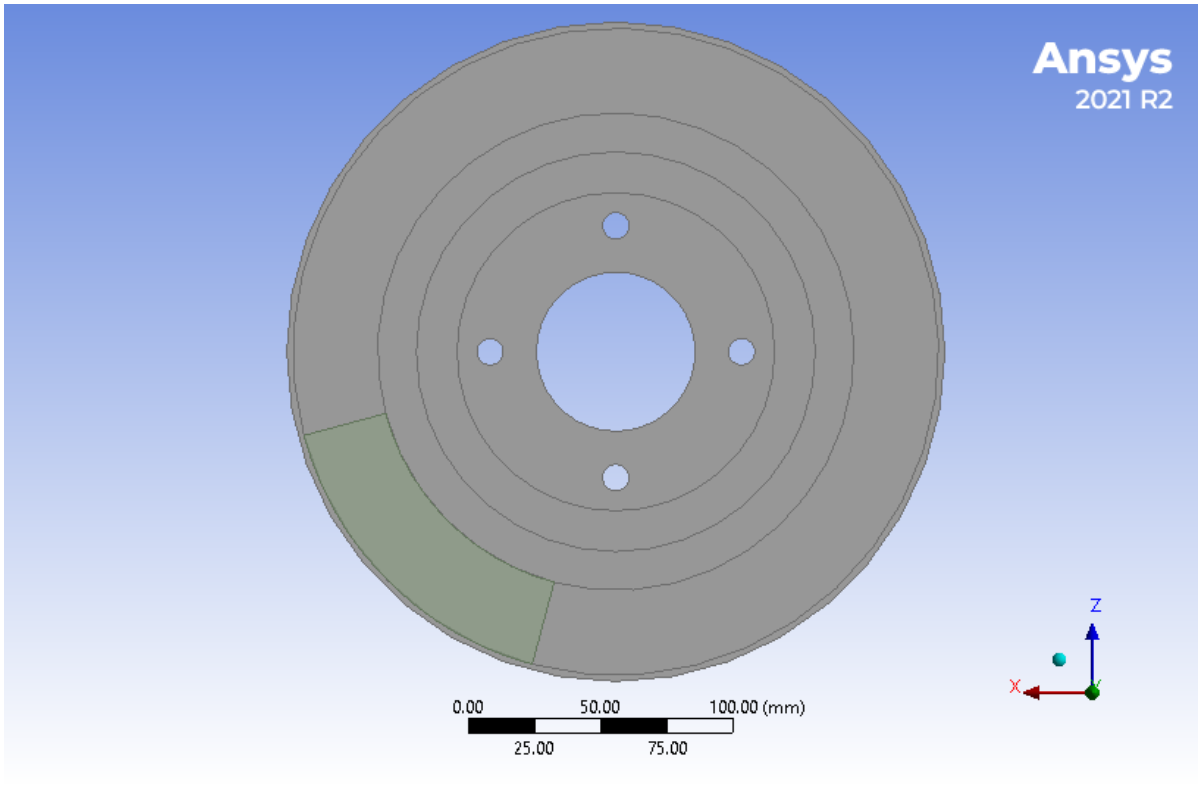
Xiangyu Gao

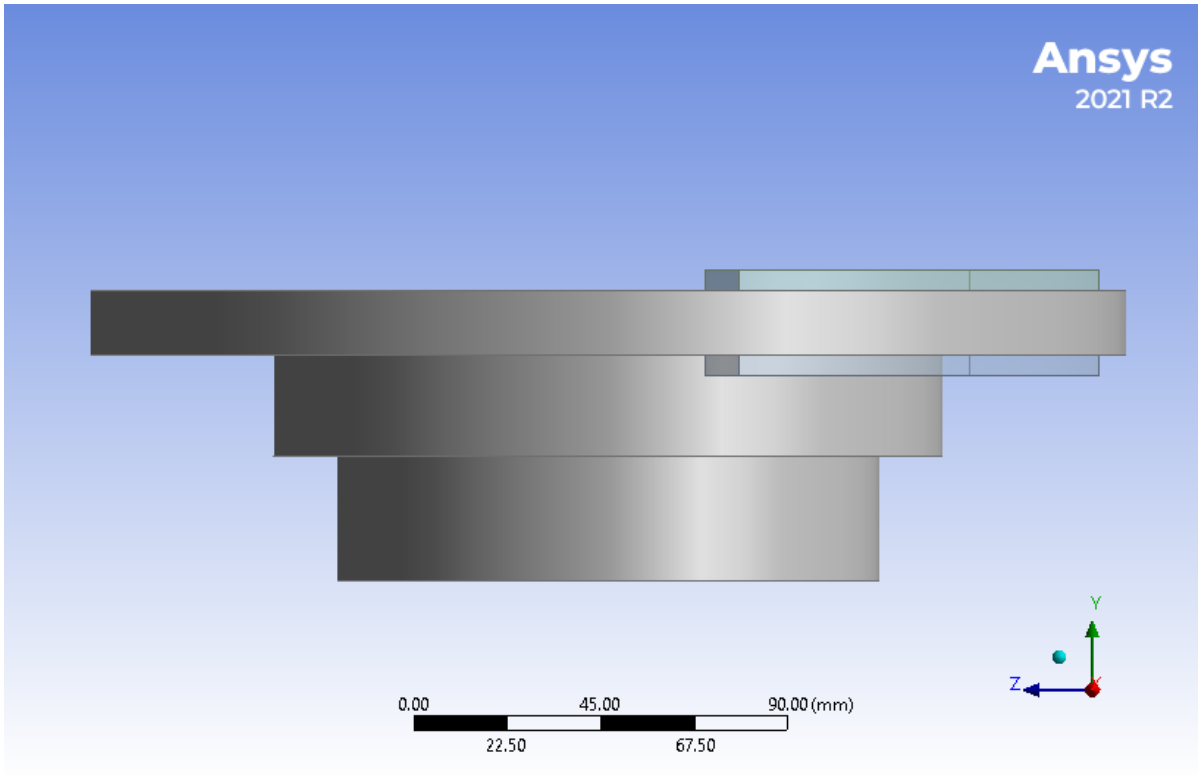
Initial Design:





Optimized Design:





Comparison:

#	P1 - rotor_thickness [mm]	P2 - rotor_OD [mm]	P3 - rotor_ID [mm]	P4 - Equivalent Stress Maximum [Pa]	P5 - Total Deformation Reported Frequency [Hz]	P7 - Solid Volume [m^3]	P8 Temper Maxim [C]
Original	25	125	75	13089990.63	1590.413022	0.00099667	335.377
Optimized	15.46660247	124.320441	80.37437554	11194720.15	1363.784035	0.000667389	400.860
Percentage Difference	-38%	-1%	7%	-14%	-14%	-33%	20%

Design of experiment

Setting of DOE:

Properties of Outline A2: Design of Experiments

	A	B
1	Property	Value
2	Design Points	
3	Preserve Design Points After DX Run	☐
4	Failed Design Points Management	
5	Number of Retries	0
6	Design of Experiments	
7	Design of Experiments Type	Latin Hypercube Sampling Design
8	Samples Type	User-Defined Samples
9	Random Generator Seed	0
10	Number of Samples	50
11	Design Point Report	
12	Report Image	None

Design Points:

#	P1 - rotor_thickness (mm)	P2 - rotor_OD (mm)	P3 - rotor_ID (mm)	P4 - Equivalent Stress Maximum (Pa)	P5 - Total Deformation Reported Frequency (Hz)	P7 - Solid Volume (m^3)	P8 - Temperature Maximum (C)
1	13.4	124.42	85.4	11776116.72	1241.027274	0.000593569	434.8775024
2	17	127.9	74.2	11477293.46	1398.168075	0.000788132	377.682373
3	6.6	129.1	67.8	10847692.28	873.1619937	0.00043747	732.2936401
4	15	127.54	85	11730357.28	1229.609557	0.000673469	402.4036865
5	7.4	125.38	69.4	10995317.73	1058.925926	0.000445901	670.8550415
6	24.6	125.86	78.2	11213562.25	1506.823652	0.000974109	335.5645447
7	14.6	128.38	84.2	11203754.7	1231.5638	0.00067517	408.087616
8	24.2	127.66	66.2	11720715.35	1576.8467	0.001087906	335.7678223
9	9.8	126.22	72.2	11176831.91	1215.591697	0.000531721	534.067688
10	8.6	129.94	68.2	11477784.88	982.7671199	0.000519011	587.244751
11	11.4	124.06	69	11169159.61	1294.705085	0.000571803	484.9203491
12	8.2	126.94	75	11267606.03	1173.425213	0.000481474	612.5980225
13	13	126.7	71.4	11167249.32	1315.129805	0.000646442	438.3731689
14	18.2	129.58	73.4	11479290.28	1389.34246	0.000857796	366.0932312

#	P1 - rotor_thickness (mm)	P2 - rotor_OD (mm)	P3 - rotor_ID (mm)	P4 - Equivalent Stress Maximum (Pa)	P5 - Total Deformation Reported Frequency (Hz)	P7 - Solid Volume (m^3)	P8 - Temperature Maximum (C)
15	11	125.14	85.8	11188763.87	1218.998373	0.000537198	493.186554
16	21.8	128.74	82.6	11660502.64	1330.417179	0.000906273	343.9168091
17	21	127.06	69.8	11641750.45	1523.342031	0.000937393	348.736145
18	16.6	129.7	81.8	11699734.68	1269.989133	0.000763826	381.6455383
19	7.8	126.46	77.4	10867573.08	1207.400743	0.000464734	639.2518311
20	7	129.82	79	10910179.13	1099.609662	0.000458722	695.8562012
21	12.6	127.78	75.8	11317514.24	1298.919399	0.000632929	446.1399841
22	22.2	125.02	82.2	11704399.99	1390.028486	0.000855812	344.5933838
23	25	129.22	80.2	11885113.88	1417.505615	0.001035938	333.0449219
24	9	124.78	73.8	11093019.66	1251.814795	0.000493386	574.4133301
25	19.4	127.18	68.6	11083616.04	1475.61163	0.000888786	357.9906311
26	16.2	126.34	77	11624954.39	1395.632484	0.000728854	387.6519775
27	20.6	126.1	80.6	11651632.3	1390.302081	0.000839769	351.2210999
28	17.8	124.9	71.8	11362951.77	1498.567857	0.00078445	373.0180664
29	25.4	125.98	67.4	11332590.93	1656.448621	0.001089866	333.513092
30	11.8	128.62	76.6	11146843.55	1259.835186	0.000612592	465.3135681
31	19.8	128.98	71	12010291.05	1447.025068	0.00091894	354.5855713
32	21.4	128.5	67	11404373.22	1486.025574	0.000992955	345.6110535
33	13.8	126.58	78.6	11259248.22	1338.267406	0.000650716	422.8503723
34	22.6	128.26	81.4	11711353.28	1370.726762	0.000931584	340.7121887
35	12.2	128.86	77.8	11034318.48	1265.672129	0.000625505	454.9656067
36	10.2	124.54	70.2	11279116	1249.679908	0.000534144	522.996582
37	23.8	127.3	76.2	11533676.87	1506.59804	0.000992963	337.0873108
38	23.4	125.5	81	11676212.19	1427.424017	0.000908104	339.48526
39	15.8	124.18	75.4	11193494.1	1451.283443	0.0006959	396.7245789
40	25.8	129.46	79.4	12065278.51	1446.151583	0.001074235	331.061554
41	15.4	125.62	73	11285689.65	1420.933603	0.000710067	398.8190613
42	14.2	129.34	72.6	11058808.42	1293.272412	0.000714221	414.065155
43	18.6	124.66	70.6	11353362.76	1525.860123	0.000813182	366.7015381
44	9.4	125.74	83	11540822.54	1253.821742	0.000503385	552.2085571
45	20.2	125.26	84.6	11894083.89	1307.388783	0.000787395	354.9075317
46	19	128.02	83.8	11437976.08	1282.728628	0.000801999	360.3261108
47	23	124.3	74.6	11450649.5	1577.784102	0.000924173	342.796936
48	17.4	126.82	66.6	11634873.47	1401.82672	0.000820062	374.599884

#	P1 - rotor_thickness (mm)	P2 - rotor_OD (mm)	P3 - rotor_ID (mm)	P4 - Equivalent Stress Maximum (Pa)	P5 - Total Deformation Reported Frequency (Hz)	P7 - Solid Volume (m^3)	P8 - Temperature Maximum (C)
49	10.6	128.14	83.4	10833330.01	1217.9764	0.000556578	501.7849426
50	6.2	127.42	79.8	10613963.2	1140.959848	0.000420426	775.1196899

Response Surface

Goodness of Fit:

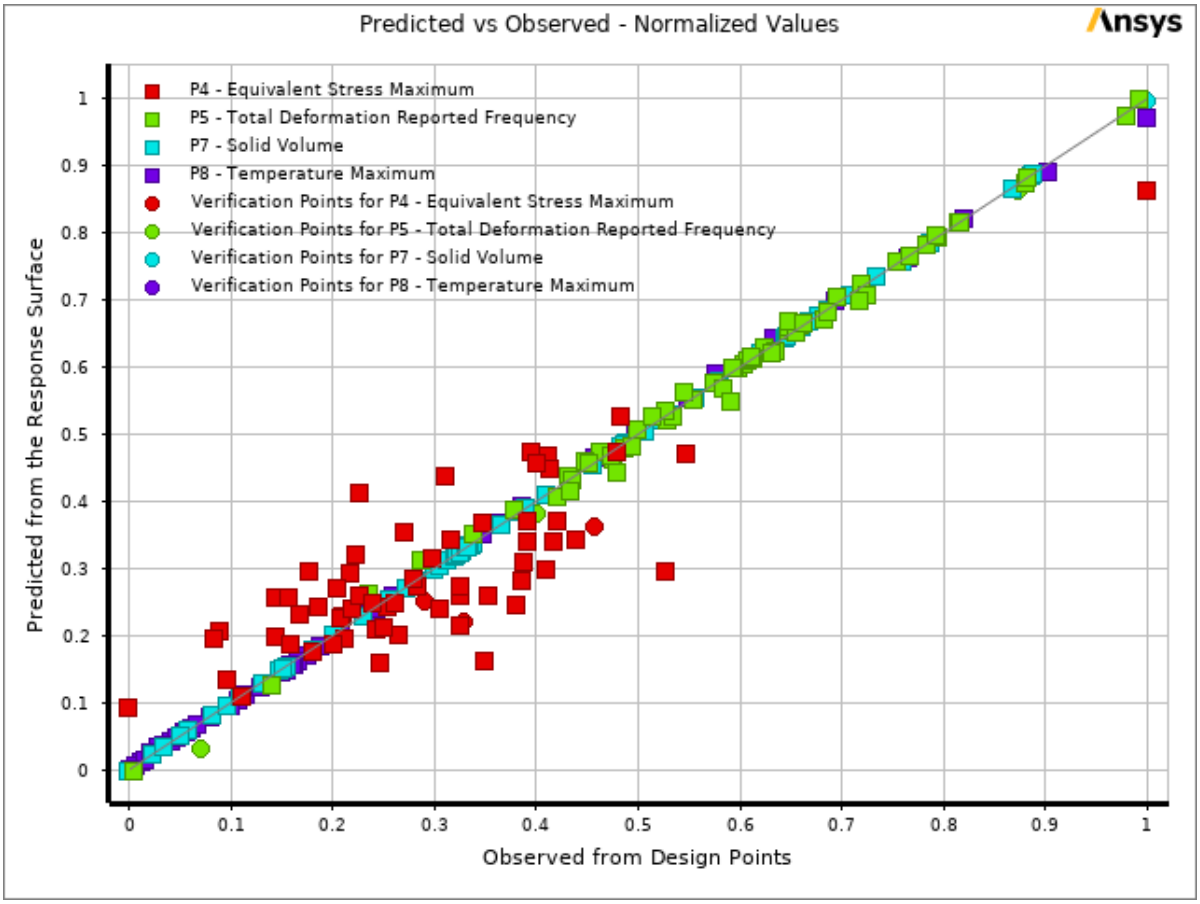
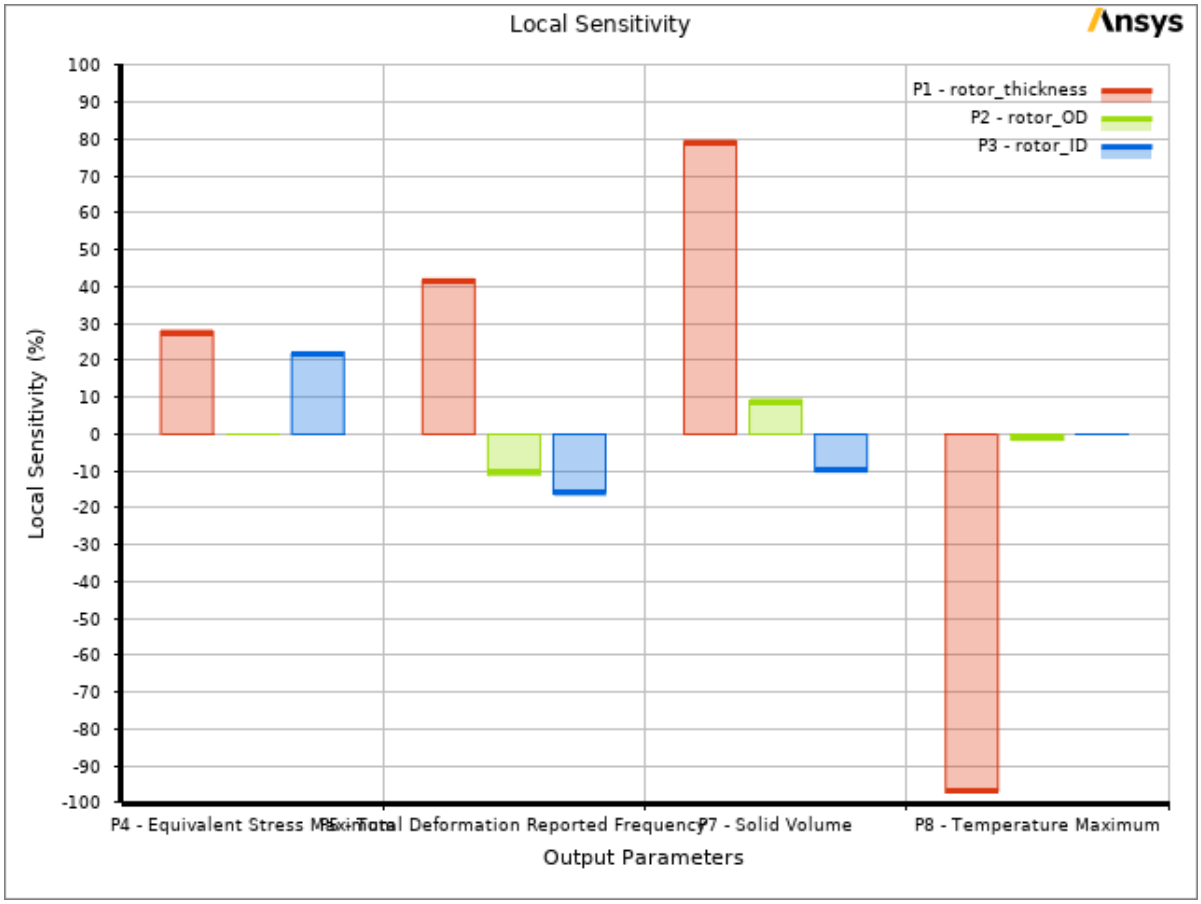
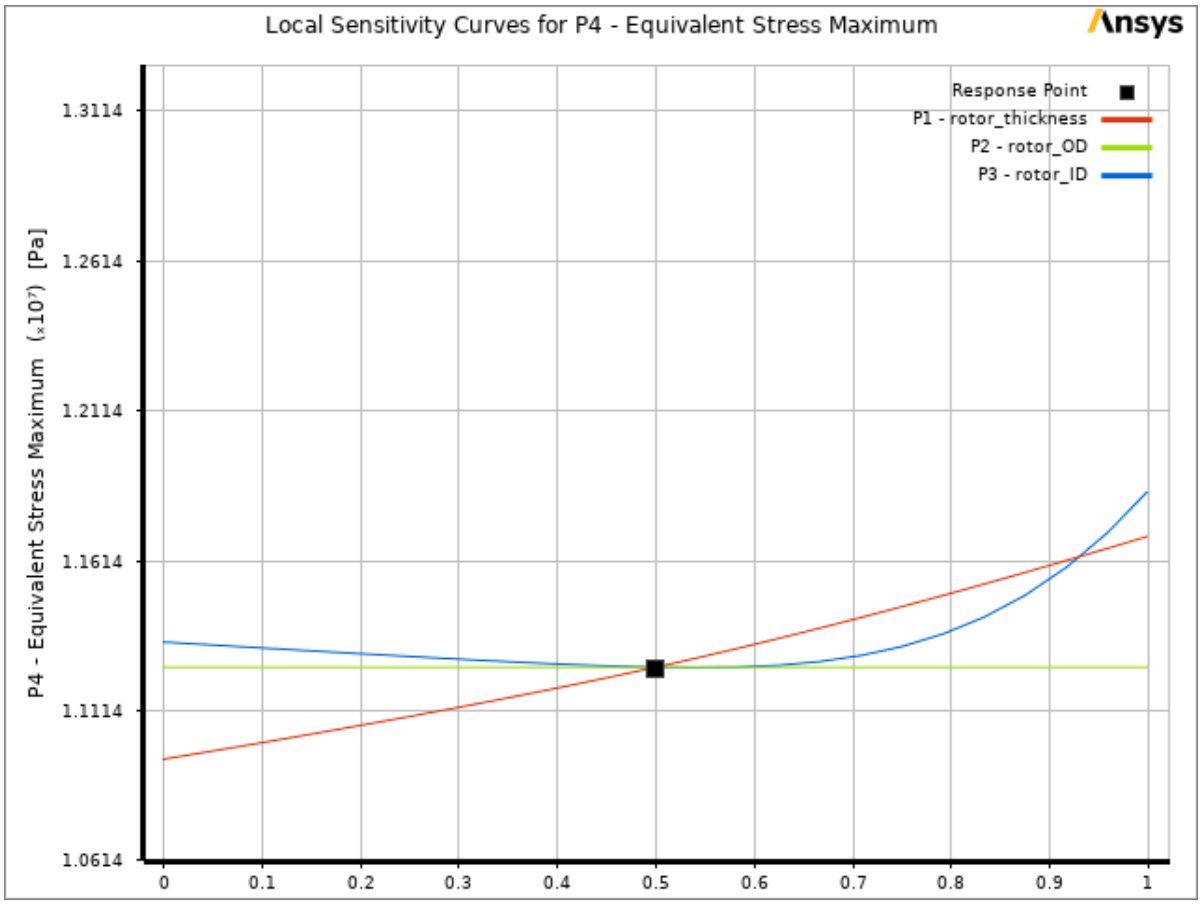


Table of Schematic D3: Response Surface

	A	B	C	D	E
1		P4 - Equivalent Stress Maximum	P5 - Total Deformation Reported Frequency	P7 - Solid Volume	P8 - Temperature Maximum
2	Coefficient of Determination (Best Value = 1)				
3	Learning Points	0.68799	0.99539	1	0.9995
4	Root Mean Square Error (Best Value = 0)				
5	Learning Points	2.1767E+05	9.8542	6.0682E-08	2.3995
6	Verification Points	2.4668E+05	22.095	2.0596E-07	1.4823
7	Relative Maximum Absolute Error (Best Value = 0%)				
8	Learning Points	155.24	23.435	0.10098	11.054
9	Verification Points	81.092	21.606	0.21227	2.6793
10	Relative Average Absolute Error (Best Value = 0%)				
11	Learning Points	44.483	4.9835	0.023373	1.5197
12	Verification Points	50.979	11.6	0.078632	1.0011

Sensitivity:





Optimization

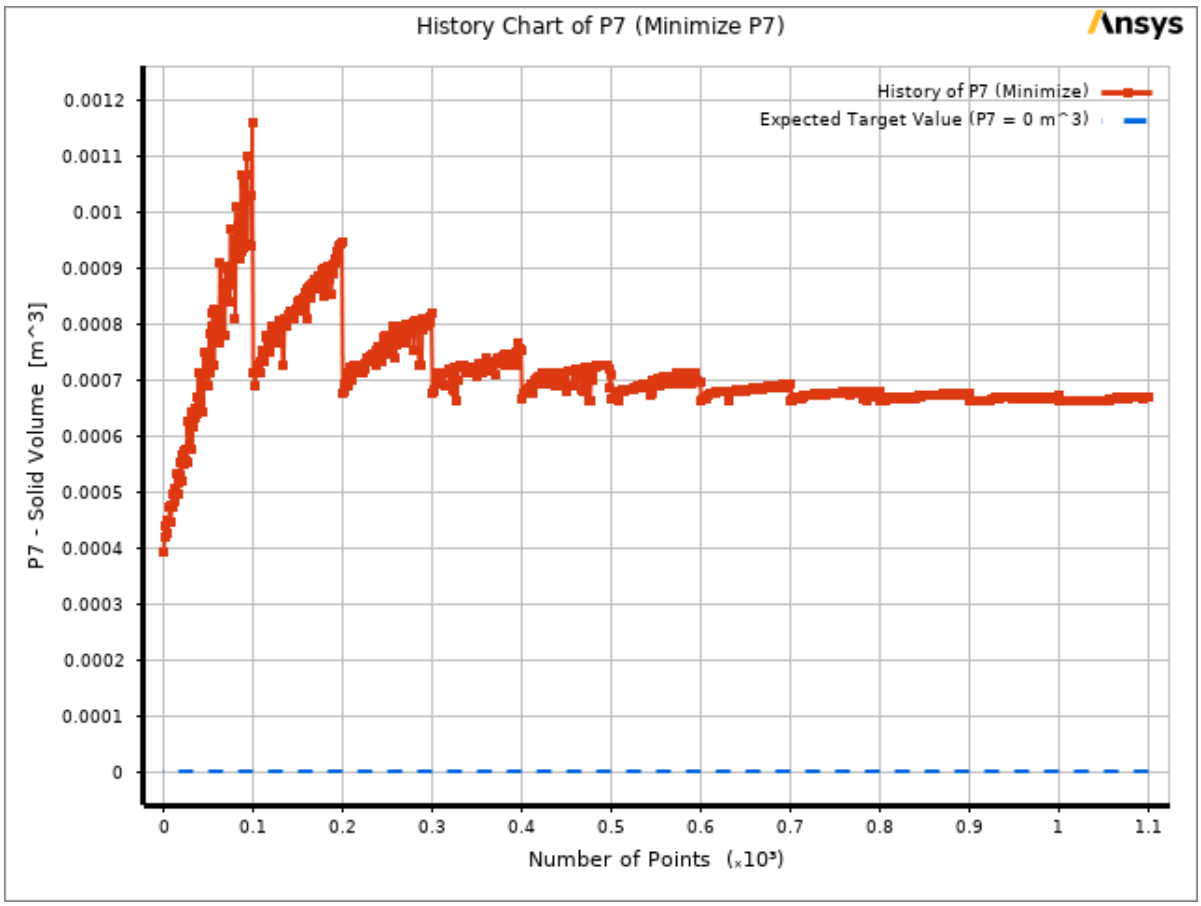
Optimization Setting:

Properties of Outline A2: Optimization

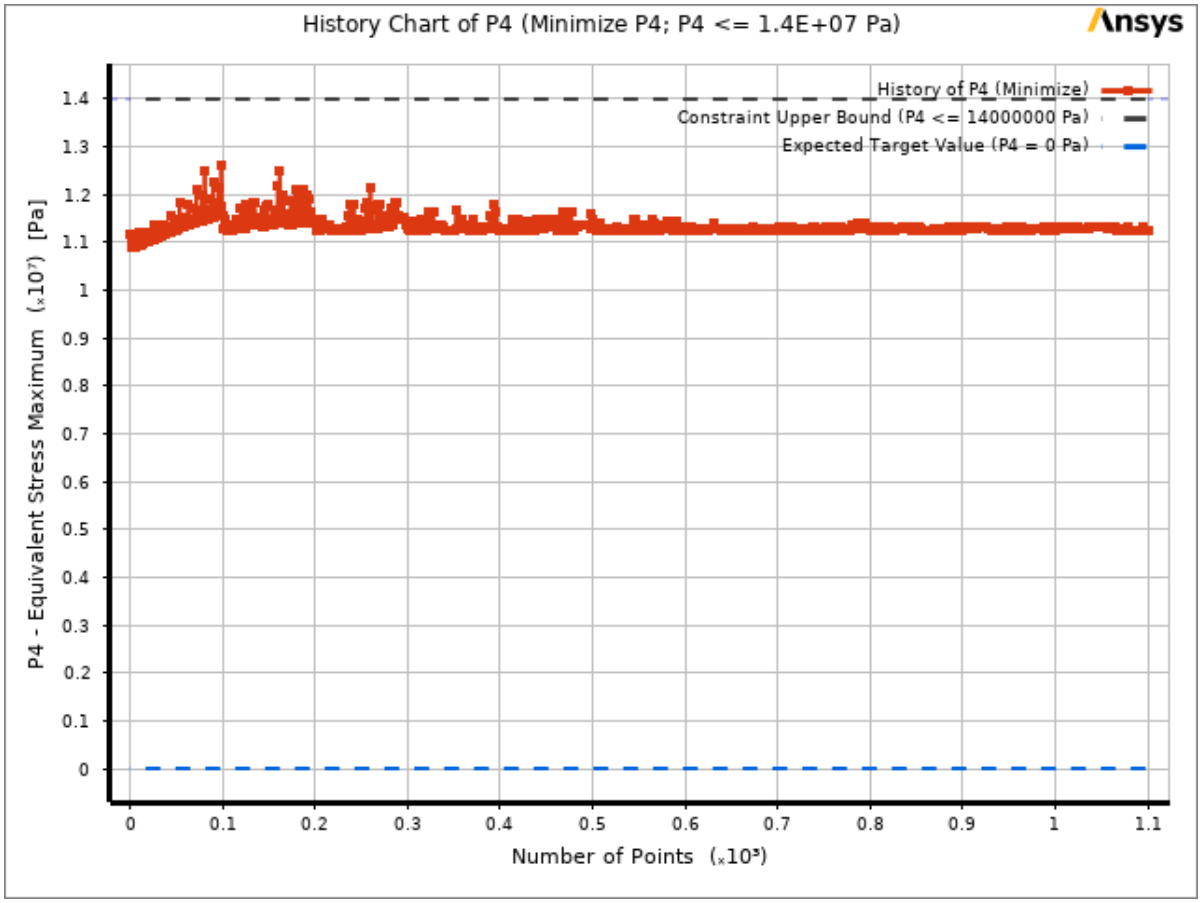
	A	B
1	Property	Value
6	Optimization	
7	Method Selection	Manual
8	Method Name	MOGA
9	Estimated Number of Evaluations	2000
10	Tolerance Settings	☑
11	Verify Candidate Points	☑
12	Number of Initial Samples	100
13	Number of Samples Per Iteration	100
14	Maximum Allowable Pareto Percentage	70
15	Convergence Stability Percentage	2
16	Maximum Number of Iterations	20
17	Maximum Number of Candidates	3
18	Optimization Status	
19	Converged	Yes
20	Pareto Percentage	1
21	Stability Percentage	1.1195
22	Number of Iterations	11
23	Number of Evaluations	950
24	Number of Failures	0
25	Size of Generated Sample Set	100
26	Number of Candidates	3

Convergence

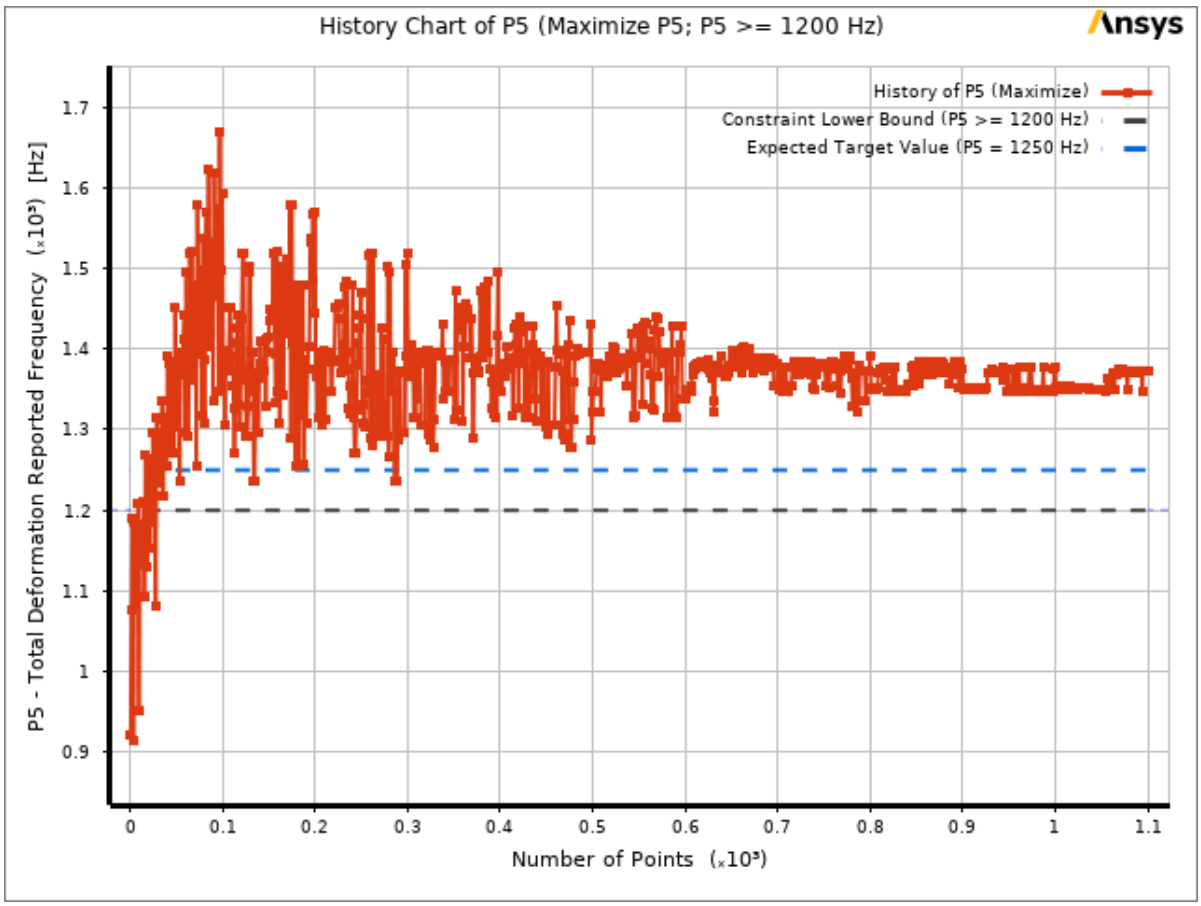
Volume of Disk:



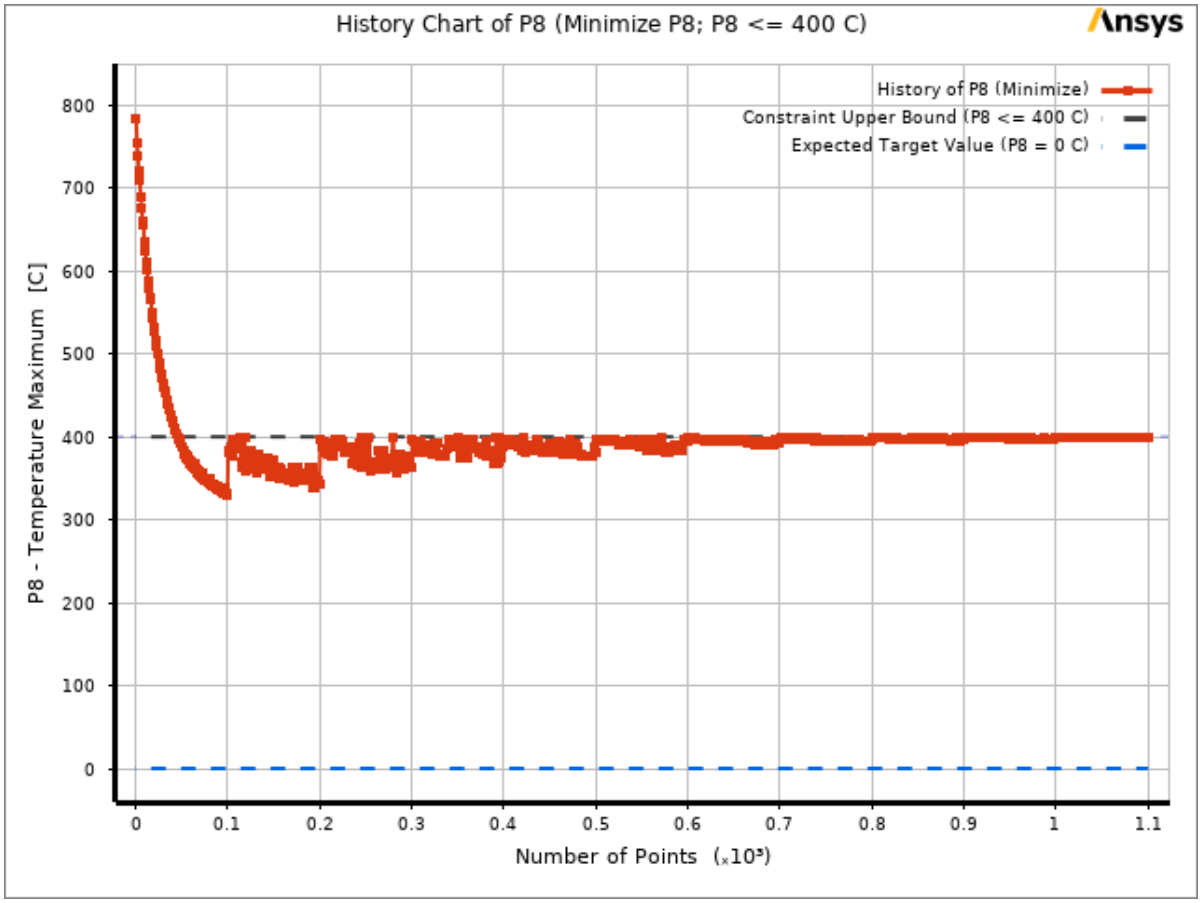
Maximum Stress:



Natural Frequency:



Maximum Temperature:



Optimized Result (Verified):

Table of Schematic E4: Optimization

	A	B	C	D	E	F	G
1	Optimization Study						
2	Minimize P4; P4 <= 1.4E+07 Pa	Goal, Minimize P4 (Default importance); Strict Constraint, P4 values less than or equals to 1.4E+07 Pa (Default importance)					
3	Maximize P5; P5 >= 1200 Hz	Goal, Maximize P5 (Default importance); Strict Constraint, P5 values greater than or equals to 1200 Hz (Default importance)					
4	Minimize P8; P8 <= 400 C	Goal, Minimize P8 (Default importance); Strict Constraint, P8 values less than or equals to 400 C (Default importance)					
5	Minimize P7	Goal, Minimize P7 (Default importance)					
6	Optimization Method						
7	MOGA	The MOGA method (Multi-Objective Genetic Algorithm) is a variant of the popular NSGA-II (Non-dominated Sorted Genetic Algorithm-II) based on controlled elitism concepts. It supports multiple objectives and constraints and aims at finding the global optimum.					
8	Configuration	Generate 100 samples initially, 100 samples per iteration and find 3 candidates in a maximum of 20 iterations.					
9	Status	Converged after 950 evaluations.					
10	Candidate Points						
11		Candidate Point 1	Candidate Point 1 (verified)	Candidate Point 2	Candidate Point 2 (verified)	Candidate Point 3	Candidate Point 3 (verified) DP
12	P1 - rotor_thickness (mm)	15.463		15.531		15.467	
13	P2 - rotor_OD (mm)	124.2		124.09		124.32	
14	P3 - rotor_ID (mm)	81.146		81.269		80.374	
15	P4 - Equivalent Stress Maximum (Pa)	1.1304E+07	1.1472E+07	1.1313E+07	1.1497E+07	1.1277E+07	1.1195E+07
16	P5 - Total Deformation Reported Frequency (Hz)	1352.4	1350.1	1351.7	1349.8	1364.7	1363.8
17	P7 - Solid Volume (m^3)	0.00066265	0.00066264	0.00066257	0.00066257	0.00066742	0.00066739
18	P8 - Temperature Maximum (C)	399.98	401.29	399.74	400.66	399.34	400.86