Project 2

Design Optimization

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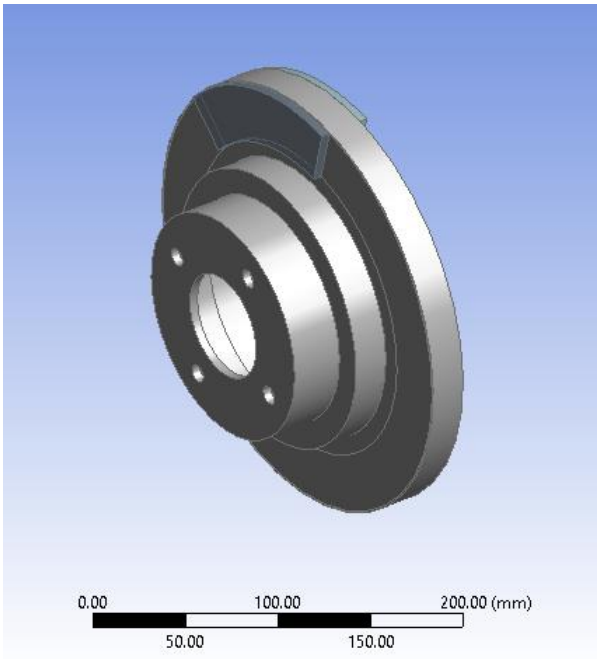
Abstract:

A disk break is to be optimized to achieve an the following objectives to (1) minimizie the overall volume of the component, (2) Minimize the maximum stress in the rotor, (3) Maximize the 1st deformation frequency response of the break, (4) Minimize the maximum temperature of the break disk.

Ansys is used to simulate the mechanics of the brake pads applying a fixed pressure onto the brake rotor and mechanical, modal and thermal responses of the system under breaking conditions are simulated to understand system dynamics under breaking conditions to mechanical, thermal and harmonic responses of the system.

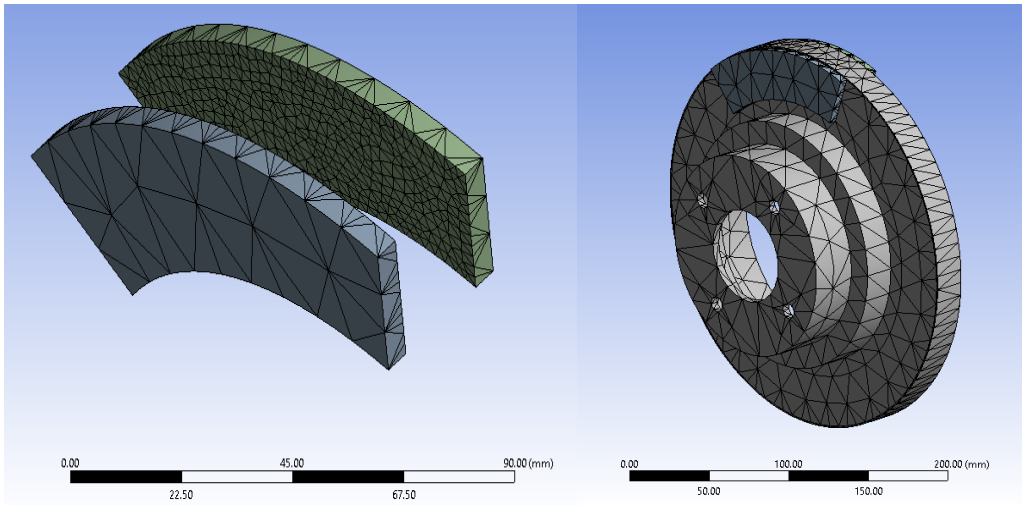
Model:

Model of the braking pads and rotors were provided, and materials were specified as Gray Cast Iron for the rotor and structural steel at the brake pads.



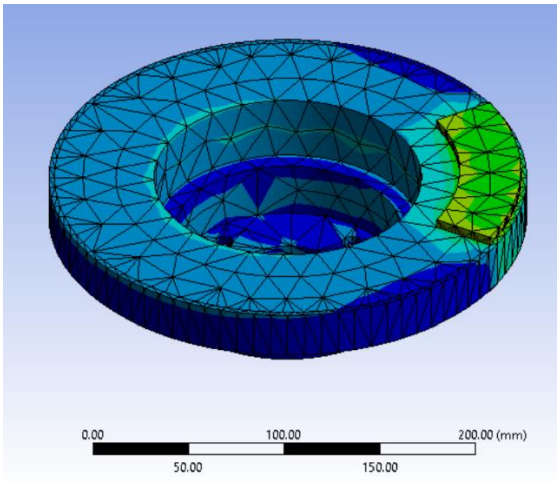
Mesh:

A patch conforming tetrahedron method was implemented to mesh the rotor geometry. Mesh sizing refinement was implemented at the

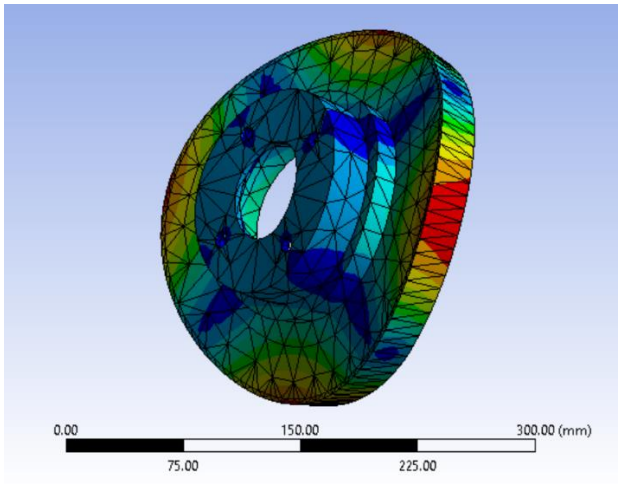


Static Structural (stress):

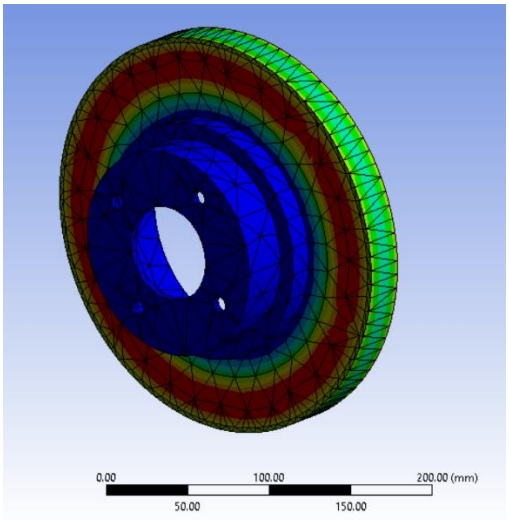
Static Structural Analysis was implemented to simulate braking



Modal:



Transient Thermal:



Optimization:

The applied design optimization to the brake system considered (1) Total Volume, (2) Maximum Von-Misses Stress, (3) Maximum Temperature, and (4) Deformation onset frequency. The respective system characteristic objectives were defined as minimize (1), minimize (2), minimize(3), and maximize(4) these parameters are characterized in (table). Additional constraints were defined at the design parameters (5) Rotor thickness, (6) Inside cut diameter(id), and (7)Rotor outside diameter(od).

Adaptive Multi Objective Direct optimization was implemented with an automated set-up and run time index of "3".

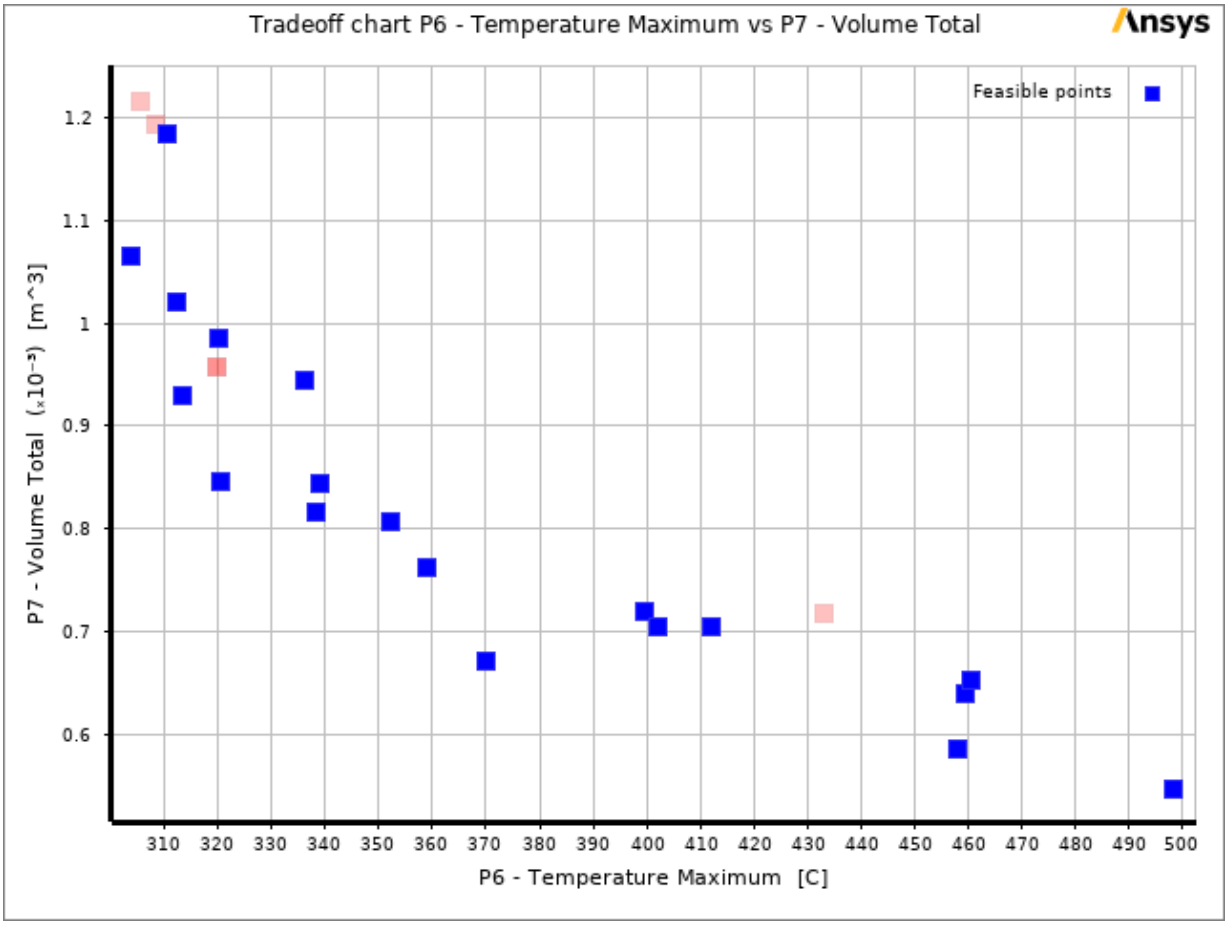
What are your design variables, constraints, and objectives?

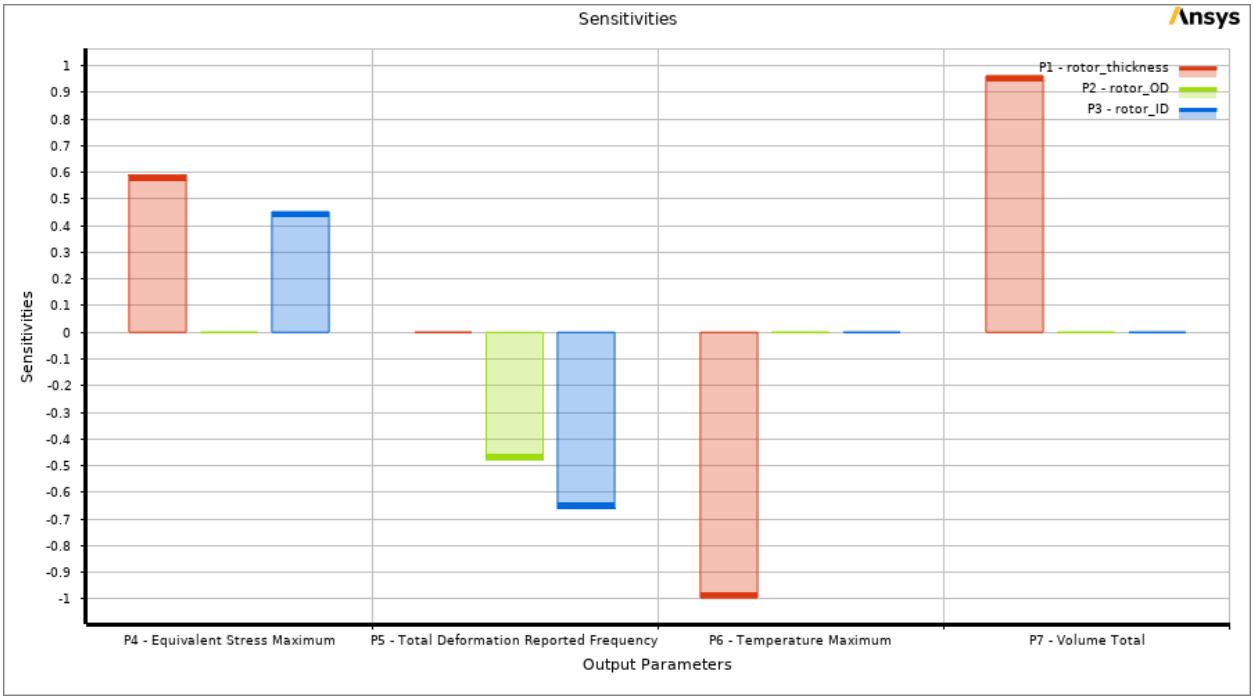
Volume Total	Minimize
Equivalent Stress Maximum	Minimize
Total Deformation Reported Frequency	Maximize
Temperature Maximum	Minimize
rotor_thickness	Bounded
rotor_OD	Bounded
rotor_ID	Bounded

Input Parameter	Lower Bound (mm)	Upper Bound (mm)	Incriment Delta (mm)	Objective:
Rotor Thickness	10	27	.5	Minimize
Inside Diameter	72	88	.5	Maximize
Outside Rotor Diameter	123	138	.5	Minimize

What are the potential trade-offs between your objectives?

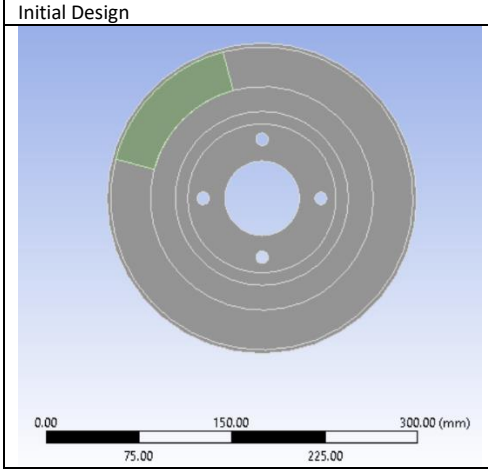
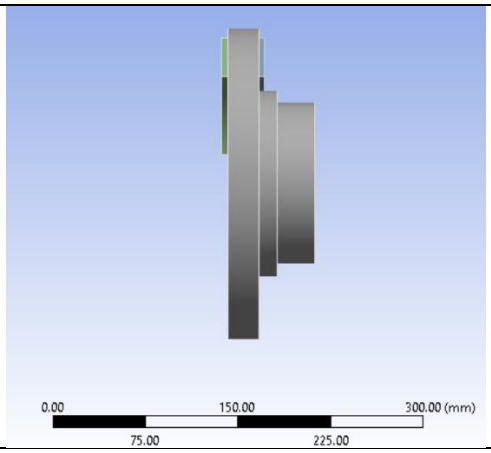
Investigating the ANSYS generated trade-off plots specific to the optimization objective there is one clear trend which.





Compare your optimal design against the initial one (e.g., see the following comparison on the brake disc design) AND comment on whether the optimal design is reasonable.

	rotor_thickness (mm)	rotor_OD (mm)	rotor_ID (mm)	Equivalent Stress Maximum (MPa)	Total Deformation Reported Frequency (Hz)	Temperature Maximum (C)	Volume Total (m^3)
Reference Geometry	25	125	75	12.547	2081.2	308.25	0.0010322
Candidate Point 1	24	125.5	73.5	12.15978093	2084.535836	312.2363892	0.00102187
Candidate Point 2	27	124.5	77	12.31330233	2082.471355	303.9928284	0.001065637
Candidate Point 3	16.5	124	72.5	12.28977806	1978.890647	358.9886475	0.000762829
Optimal Candidate Check							
Precentace Difference				2.071298755	5.039757092	15.20854574	30.01297594
Increase / Decrease				Decrease	Decrease	Increase	Decrease

Initial Design	
	

Optimal Design