BRAKE SYSTEM OPTIMIZATION
FORMULA CHEAT SHEET

Longitudinal Load Transfer
Load Transfer = (Deceleration x Mass x COG Height) / Wheelbase

Force, Pressure & Area
Force = Pressure x Area
Pressure = Force / Area
Area = Force / Pressure

Coefficient of Friction (μ)
μ = Friction Force / Normal Force
Friction Force = μ x Normal Force
Normal Force = Friction Force / μ

Tire Forces
**assuming tire μ = deceleration*
Vertical Tire Load (N) = Weight (kg) x 9.807
Longitudinal Tire Force (N) = Vertical Load (N) x Deceleration (G)

Torque Calculation
Torque = Force x Distance
Brake Torque = Friction Force x Effective Disk Radius
Braking Capacity = Longitudinal Force x Wheel Radius

Bias Calculation
Bias Front % = (Front / (Front + Rear)) x 100
eg. Weight Bias % = Front Weight (kg) / (Front+Rear Weights (kg)) x100

Pedal Ratio
Pedal Ratio = Pivot to Centre of Pedal Pad / Pivot to Push rod
eg. 200mm / 40mm = 5.0:1 Pedal Ratio

Effective Disc Radius
Effective Disc Radius = Disc Outer Radius - Pad Radius
eg. 150mm - 40mm = 110mm Effective Disc Radius

Pad Force Requirement
Pad Force Requirement/Axle (N) =
Torque Capacity / 2 x (μ (Effective Disc Radius in meters))

Area, Volume & Displacement
Area of a Circle = Pi (π) x Radius^2
Volume = Area x Displacement
Displacement = Volume / Area

Hydraulic Pressure Requirement
Hydraulic Pressure Requirement (Pa) =
Pad Force Requirement (N/Per Pad) / Piston Area (m^2)

Brake Force Input
Brake Force (Per MC) = Pedal Effort (kg) x Pedal Ratio / Bias Position
eg. 50kg x 5 / 0.5 = 125kg Per Master Cylinder = 1225N (MC Force)

Target Master Cylinder Bore Size
MC Area (m^2) = MC Force (N) / Hydraulic Pressure Requirement (Pa)
MC Bore Diameter = 2 x (√MC Area / Pi)

Hydraulic Leverage
Leverage Ratio/Axle = (Caliper Piston Area / MC Area) x Pedal Ratio
Leverage Bias % = (Leverage Front / Leverage Total) x 100

Common Problems & Potential Solutions

Brake Pedal gets soft, spongy and/or long during session or race:	Fluid boiling in calipers. Not pad fade! Upgrade fluid and/or caliper cooling.
Brake Pedal is soft, spongy and/or long before car has even run:	Air in System - Bleed brakes.
	Brake pads severely tapered - Replace pads.
	Excessive compliance (low stiffness) in calipers or pedal box.
Reduced stopping power with normal brake pedal feel:	Pad fade, due to unbedded (new) pads or outside pad temperature window.
Long brake pedal with little effort required:	Master Cylinder(s) too small, over assisted brake booster or pedal mechanical advantage too great.
Rough braking - Vibrates under braking:	Deposits on disc - Clean/grind/replace discs, upgrade/rebed pads, improve cooling.
	Distorted discs - Grind/Replace discs | More even cooling.
	Insufficient (or no) axial float on floating discs.
Uneven braking - Car pulls to one side:	Stuck pistons - Rebuild Calipers.
Brake Bias changes during application:	Excessive clearance between mc push rod clevises and bias bearing housing.
Tapered pad wear:	Leading Edge - Staggered Pistons
	Radial - Improve Cooling/Reduce Annulus
	Caliper compliance or non-square mounting
Soft pedal on initial application:	Knock-off/knock-back - Compliance in corner assembly (caliper,hub,upright)
Overheating despite quality cooling:	Insufficient thermal mass - Use thicker discs and/or pads