High School Mathematics - This document contains Common Core connections to be used as a guideline in conjunction with ***Being Relevant Matters*****,** a NATEF publication on English, Math and Science integration with automotive technology at the MLR, AST or MAST program accreditation level.

MATHEMATICAL BEST PRACTICES

The following apply to the entire set of objectives:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

2013 NATEF Automobile Accreditation

MATH OBJECTIVES	COMMON CORE CONNECTION
I. ENGINE REPAIR ***Engine Size Conversion (CID, CC, Liters)*** ➢ Convert inches to cm and vice versa ➢ Convert square inches to square cm and vice versa ➢ Convert cubic inches to cubic cm ➢ Build scale models of cm^3, in^3, Liter ➢ Develop conversion chart ➢ Practice converting and comparing engine sizes	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities* *G-MG1* *Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).⋆*
Cylinder Volume ➢ Intro area based volume definition ➢ Develop formulas for standard 3D geometric figures ➢ Intro to volume of sphere ➢ Find volumes of standard and composite 3D geometric figures ➢ Find missing dimensions given volumes ➢ Intro terms bore and stroke, create formula for the displacement of an engine, and find displacements of engines given bore and stroke ➢ Measure bore and stroke with micrometer/caliper and determine displacement ➢ Solve for bore and stroke ➢ Graph volume vs. stroke and/or volume vs. bore to show difference in linear vs. quadratic growth	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities* *G-MG1* *Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).⋆* *G-GMD1* *Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.* *G-GMD3* *Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.⋆* *A-CED1* *Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.* *F-BF1* *Write a function that describes a relationship between two quantities.⋆* *F-LE5* *Interpret the parameters in a linear or exponential function in terms of a context.*

MATH OBJECTIVES	COMMON CORE CONNECTION
I. ENGINE REPAIR ***Cams and Timing*** ➢ Define angles and develop standard notation schemes ➢ Create and measure angles with a protractor ➢ Develop relationships and properties of angles including Angle Addition Postulate, Vertical angles, Complementary angles, Supplementary angles, Angle Sum Theorem, rotational angles ➢ Define arcs and arc measure ➢ Solve applied arc problems ➢ Construct circles, arcs, perpendicular bisectors, and angle bisectors to "construct" cam lobes ➢ Define duration (advertised and actual) and overlap ➢ Using Valve opening and closing to determine duration of each of the four parts of the engine cycle ➢ Determine valve overlap ➢ Define lift ➢ Measure the lift of a cam lobe ➢ Define Rocker arm ratio ➢ Use Rocker Arm ratio to determine lift at the valve	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.* *G-CO1* *Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.* *G-CO9* *Prove theorems about lines and angles.* *G-CO12* *Make formal geometric constructions with a variety of tools and methods.*
II. AUTOMATIC TRANSMISSION ➢ Define Gear ratio ➢ Determine gear ratios from pulley size or number of teeth (i.e. pinion to ring to find differential ratio) ➢ Determine the effect of gear ratio on RPM and on torque ➢ Determine gear ratios for planetary gear sets. ➢ Define pressure as a function of force and area ➢ Solve for the force on the piston return spring when changing shift points under various pressures	*A-REI1* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*

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III. Manual Transmission ***Simple Gears*** ➢ Define gear ratio ➢ Determine gear ratios from pulley size or number of teeth (i.e. pinion to ring to find differential ratio) ➢ Determine the effect of gear ration on RPM and on torque() ➢ Applications on RPM and torque (i.e. jimmy is pedaling at this rate and the tire is spinning at this rate)	*A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.* *F-BF1* *Write a function that describes a relationship between two quantities.⋆* *F-LE5* *Interpret the parameters in a linear or exponential function in terms of a context.*
Gear Trains ➢ Multiplicative property of multiple gear ratio to determine final gears ➢ Engine speed to road speed (use engine RPM transmission ratio, rear end rations and tire size)	*A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*
IV. Suspension and Steering ➢ Determine gear ration of rack and pinion system ➢ Compare steering wheel rotations to turn angles ➢ Discuss inside and outside turning radii ***Alignment Angles*** ➢ Define angles and develop standard notation schemes ➢ Create and measure angles with a protractor ➢ Develop relationships and properties of angles including angle addition postulate, vertical angles, complementary angles, supplementary angles, angle sum theorem, rotational angles ➢ Introduce degrees, minutes and second ➢ Convert from DMS to DD (i.e. comparing different manufacturers specs) ➢ Define camber, caster, toe, SAI, included angle, and thrust angle. Include description of the directionality of each of the above angles (i.e. positive toe is toward the center line.) ➢ Measuring ride height (i.e. effects of improper ride height on alignment angles)	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.* *G-CO1* *Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.* *G-CO9* *Prove theorems about lines and angles.*
Handling ➢ Determine center of gravity from weight distribution and from measured weight ➢ Compare slalom speeds and lateral g's (skidpad) for multiple vehicles ➢ Determine lateral acceleration from skidpad lap times and speeds	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*

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V. Brakes ***Levers (brake pedal)*** ➢ Classify levers as I, II, or III ➢ Define Mechanical Advantage ➢ Measure and determine Mechanical advantage (i.e. Measure the pedal to fulcrum and from brake pedal travel adjustment to fulcrum to determine the mechanical advantage of the brake pedal) ➢ Identify gain or loss of force and distance based on lever design ➢ Use mechanical advantage to determine force and (distance) travel of levers	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*
Braking Area of braking components ➢ Define area ➢ Develop Formulas for areas of standard 2d shapes (rectangles, parallelograms, triangles, circles) ➢ Find areas of standard and composite 2D geometric figures ➢ Find missing dimensions given area ➢ Determine area of various brake pads ➢ Determine the braking area of a brake rotor ➢ Define surface area ➢ Develop Surface area formulas for prisms, cylinders, cones, spheres and pyramids ➢ Find surface areas of standard and composite 3D geometric figures ➢ Determine the braking area of a brake drum	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *G-MG1* *Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).⋆* *G-GMD1* *Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.* *A-CED1* *Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*
Hydraulics (Pascal's Law) ➢ Use Pascal's Law to determine input and output forces	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *G-MG1* *Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).⋆* *G-GMD1* *Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*

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VI. Electrical/Electronic Systems ***Simple Circuits*** ➢ Define current, resistance, voltage, and power (use water or traffic analogy) ➢ Define abbreviations (volts, amps, Ohms, Watts) ➢ Wiring symbols (Resistors (loads), Batteries (source), switches, grounds, and fuses) ➢ Use simulator to discover and model ohms' law property ➢ Apply ohms Law to simple circuits ➢ Define series, parallel, and series-parallel circuits ➢ Use simulator to discover resistance and current properties of series, parallel, and series-parallel circuits ➢ Develop formulas/properties for total resistance, wattage (circuit check), current, and voltage in series, parallel, and series-parallel circuits. ➢ Work with circuit diagrams to solve for missing values.	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *A-CED1* *Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*
Meter Reading and Trouble Shooting ➢ Introduce a DMM to measure voltage (AC and DC), current and resistance in various units ➢ Practice using DMM's for various measurements ➢ Use simulator to discover Kirchoff's Law and voltage drop principles ➢ Apply voltage drop principles to trouble shoot circuits	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *A-CED1* *Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*
VII. Heating and Air Conditioning ***Introduction to unit of pressure (PSI and of HG) and temperature (F to C)*** ➢ Convert units of pressures and temperature ➢ Converting volumetric units ➢ Reading pressure and temperature gauges ➢ Use heat transfer equations and airflow equations	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *A-CED1* *Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*

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VIII. Engine Performance ***HP and Torque*** ➢ Define force, work, and power ➢ Define horsepower and torque ➢ Convert between hp and torque at specific RPM values ➢ Plot HP and torque curves ➢ Estimating Quarter mile times and speeds from weight and HP ➢ Explore the relationship between weight and speed (plot speed versus curb weight)	*N-RN1* *Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.* *N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *A-CED1* *Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.* *F-IF7* *Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*⋆ *F-BF1* *Write a function that describes a relationship between two quantities.*⋆ *F-LE5* *Interpret the parameters in a linear or exponential function in terms of a context.*
Air Flow ➢ Discuss units of air flow (cubic feet per minute) ➢ Use dimensional analysis to convert from CID and RPM to Cubic feet per minute ➢ Create formula for theoretical air flow ➢ Use theoretical and measured air flow to determine volumetric efficiency ➢ Discuss relative efficiencies of naturally aspirated versus forced induction engines	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *G-MG1* *Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*⋆ *G-GMD1* *Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.* *G-GMD3* *Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*⋆ *A-CED1* *Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*

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Compression Ratio ➢ Define compression ratio ➢ Measure volumes of cylinders, deck height spaces, and gasket spaces ➢ Measure head space (drip method) ➢ Calculate compression ratios ➢ Explore relationships between gasket thickness and compression ratio and head space and compression ratio	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *G-MG1* *Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*⋆ *G-GMD1* *Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.* *G-GMD3* *Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*⋆ *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.* *F-IF7* *Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*⋆ *F-BF1* *Write a function that describes a relationship between two quantities.*⋆

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Required Supplemental Tasks ***Number Sense*** ➢ Operations on whole numbers, decimals, fractions, and percents ➢ Define Place values, and Round to appropriate place values ***Measurement and Bit /Bolt Sizes*** ➢ Reading a linear scale in metric (mm oe tenth cm) or standard ($1/16^{th}$) ➢ Reading and appropriately using a metric and standard precise measurement tools (micrometers, dial calipers, dial indicators, vernier scales) ➢ Convert between and within standard and metric linear and volume units ➢ Bolt and thread identification ➢ Drill bit sizes ***Work Orders (Repair Order)*** ➢ Intro to flat rate times ➢ Reading a standard flat rate table (time and part guide) ➢ Computing labor charges ➢ Reading a parts invoice ➢ Computing part totals (mark up?) ➢ Finding subtotal and tax amounts ➢ Determine profit/loss amounts ***Tires*** ➢ Reading sidewall dimensions for standard and LT tires ➢ Define tread width aspect ratio, and rim diameter ➢ Determine tread width, Total Height, rim diameter and sidewall height in metric or standard units ➢ Determine error in speedometer and odometer after tire size changes.	*N-Q1* *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.* *N-Q3* *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.* *A-REI3* *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*