



Western Technical College

31804336 Applied Math - Transportation

Course Outcome Summary

Course Information

Description	The student will develop mathematical and problem solving skills necessary to be successful in industry. The student will apply geometric, numeric, and measurement concepts to problems related to the automotive trade. Knowledge of fractions, percents, and geometry will be used to gain a deeper understanding of mechanical concepts including drive ratio, engine displacement, horsepower, compression ratio and Pascal's Law.
Instructional Level	Technical Diploma Courses
Total Credits	2
Total Hours	72

Textbooks

No textbook required.

Success Abilities

1. Cultivate Passion: Expand a Growth-Mindset
2. Live Responsibly: Develop Resilience
3. Live Responsibly: Foster Accountability
4. Refine Professionalism: Improve Critical Thinking

Course Competencies

1. Calculate with real numbers

Assessment Strategies

- 1.1. Skill Demonstration
- 1.2. Written Objective Test

Criteria

Performance will be satisfactory when:

- 1.1. learner can perform all critical steps for each algorithm in the right order
- 1.2. learner can recognize which fractional operations require common denominators
- 1.3. learner can recognize which fractional operations require mixed numbers to be written as improper
- 1.4. learner can recognize how to handle the decimal point for all decimal operations
- 1.5. learner uses correct spelling, comma, and hyphen placement to express decimal numbers using words
- 1.6. learner can perform calculations with at least 70% accuracy

Learning Objectives

- 1.a. Convert between improper fractions and mixed numbers
- 1.b. Reduce fractions to lowest terms
- 1.c. Apply operations of addition, subtraction, multiplication and division to fractions
- 1.d. Convert numbers between fraction and decimal form
- 1.e. Convert decimals between written (word) and numeric form
- 1.f. Round decimal values to a specified precision
- 1.g. Apply operations of addition, subtraction, multiplication and division to decimal numbers
- 1.h. Evaluate arithmetic expressions using proper rules of order
- 1.i. Solve applied problems related to the transportation trades involving fractions and decimals

2. Apply ratio and proportion concepts to solve problems

Assessment Strategies

- 2.1. Skill Demonstration
- 2.2. Written Objective Test

Criteria

Performance will be satisfactory when:

- 2.1. learner uses decimal approximation and correct units to write a ratio as a unit rate
- 2.2. learner can perform any numeric or unit cancelling necessary to write a ratio in lowest terms
- 2.3. learner can solve proportions containing decimals using cross-multiplication and conventional rounding techniques
- 2.4. learner can solve proportions containing fractions by using proper fractional multiplication and division techniques
- 2.5. learner uses proportions to determine used and unused value of items carrying a pro-rated warranty, including tires and batteries, to the nearest cent
- 2.6. learner can perform all calculations with at least 70% accuracy

Learning Objectives

- 2.a. Write the ratio between given quantities as a unit rate and in lowest terms
- 2.b. Solve for the unknown quantity in a given proportion containing decimals
- 2.c. Solve for the unknown quantity in a given proportion containing fractions
- 2.d. Use proportions to calculate refund value on pro-rated items including tires and batteries

3. Apply percent concepts to solve problems

Assessment Strategies

- 3.1. Skill Demonstration
- 3.2. Written Objective Test

Criteria

Performance will be satisfactory when:

- 3.1. learner can convert between decimal numbers and percents by moving the decimal point appropriately
- 3.2. learner can convert between fractions and percents by dividing or treating percents as fractions appropriately
- 3.3. learner can identify base, rate, and amount in a percent problem, and use the $a = br$ relationship or percent proportions to solve for an unknown in such problems
- 3.4. learner can calculate the value of a percent discount, percent markup, sales tax, or any combination of these, and round the answer appropriately
- 3.5. learner can calculate the actual tolerance from a percent tolerance, and determine if a given

- measurement is within allowable range for a percent tolerance
- 3.6. learner can calculate axle weights based on percent weight distributions and total vehicle weight
- 3.7. learner can determine whether all cylinder pressures are within 15% of the highest cylinder pressure for a given engine
- 3.8. learner can perform all calculations with at least 70% accuracy

Learning Objectives

- 3.a. Convert between decimal, fraction, and percent form of a number
- 3.b. Identify the base, rate and amount within a percent application
- 3.c. Use proportions or decimal equivalents to solve problems involving percent markup, percent discount, and sales tax
- 3.d. Calculate the minimum and maximum values of an acceptable range given a nominal value and percent tolerance
- 3.e. Solve percent problems related to transportation trades including percent weight distribution and compression testing

4. Change units on measurements

Assessment Strategies

- 4.1. Skill Demonstration
- 4.2. Written Objective Test

Criteria

Performance will be satisfactory when:

- 4.1. learner can interpret all metric prefixes between micro and mega as the correct power of ten
- 4.2. learner can convert one metric prefix to another by moving the decimal point in the measurement appropriately
- 4.3. learner can set-up conversions using the unit-fraction method and show how unwanted units cancel to yield desired units
- 4.4. learner can set-up rate conversions using the unit-fraction method to convert fuel economy values, velocities, and flow rates
- 4.5. learner can convert any temperature measurement between the Kelvin, Centigrade, Fahrenheit, and Rankin scales by identifying and using the correct formula or formulas
- 4.6. learner can perform all calculations with at least 70% accuracy

Learning Objectives

- 4.a. Convert metric measurements from one prefix to another within the micro to mega range
- 4.b. Use the unit-fraction conversion method to convert measurements within the U.S. customary system and between the U.S. customary and metric systems
- 4.c. Apply the unit-conversion fraction method to conversions involving rates
- 4.d. Convert temperature measurements between the Celcius, Fahrenheit, Rankin and Kelvin scales

5. Solve problems involving geometric concepts

Assessment Strategies

- 5.1. Project: Calculate Compression Ratio of an Engine
- 5.2. Skill Demonstration
- 5.3. Written Objective Test

Criteria

Performance will be satisfactory when:

- 5.1. learner can calculate the compression ratio of an actual engine, though a lab assignment, with 100% accuracy
- 5.2. learner can use a protractor and straightedge to create a camshaft event diagram and determine the intake duration, exhaust duration, valve overlap, and intake centerline location
- 5.3. learner knows the equation of and can use the Pythagorean theorem to determine hypotenuse length given both legs, and leg length given the length of the other leg and the hypotenuse
- 5.4. learner can calculate perimeters of simple and compound shapes involving straight edges, circles, or parts of circles, after completing any conversions to make dissimilar units match
- 5.5. learner knows formulas for and can calculate areas of triangles, rectangles, parallelograms, circles, and composite shapes containing simpler shapes, using the pythagorean theorem to find critical dimensions when necessary

- 5.6. learner knows formulas for and can calculate the volume of prisms, cylinders, spheres, and composite solids composed of simpler parts
- 5.7. learner can calculate displacement of an engine given bore, stroke, and number of cylinders, and can report the displacement in cubic centimeters, cubic inches, and liters
- 5.8. learner can convert between degree-minute measurements and decimal degree measurements to determine whether a caster or camber angle is within a given tolerance
- 5.9. learner can perform all calculations with at least 70% accuracy

Learning Objectives

- 5.a. Create camshaft event diagrams using a protractor
- 5.b. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles
- 5.c. Calculate the perimeter of simple and compound geometric figures with consistent or inconsistent unit measures
- 5.d. Calculate the area of geometric figures including quadrilaterals, triangles, circles, and composite figures
- 5.e. Calculate the volume of various geometric solids including spheres, rectangular solids, cylinders, prisms, and composite solids.
- 5.f. Calculate displacement of internal combustion engines in cubic inches, cubic centimeters, liters
- 5.g. Solve problems involving camber & caster angles using decimal degree angle measure and degree & minute angle measure

6. Calculate vehicle specifications related to thermodynamics and Pascal's Law

Assessment Strategies

- 6.1. Skill Demonstration
- 6.2. Written Objective Test

Criteria

Performance will be satisfactory when:

- 6.1. learner can calculate compression ratio given an engine's bore, stroke, piston-to-deck height, head gasket thickness, piston relief volume, and combustion chamber size
- 6.2. learner can calculate the theoretic airflow and volumetric efficiency of an engine given displacement, engine speed, and actual airflow rate
- 6.3. learner can calculate the indicated horsepower, indicated torque, and mechanical efficiency of an engine given the M.E.P, displacement, engine speed, and brake torque values
- 6.4. learner can use Pascal's Law to determine the output force by brake calipers given the input force on the brake pedal for hydraulic brake system given brake system component specifications
- 6.5. learner can perform all calculations with at least 70% accuracy

Learning Objectives

- 6.a. Compute compression ratio of an engine given the necessary engine dimensions with like or mixed units
- 6.b. Calculate the theoretic airflow and volumetric efficiency of an engine at a given engine speed
- 6.c. Estimate the indicated horsepower, indicated torque, and mechanical efficiency an engine
- 6.d. Calculate resultant force applied by brake components using Pascal's Law

7. Measure using high-precision instruments

Assessment Strategies

- 7.1. Performance
- 7.2. Simulation
- 7.3. Skill Demonstration
- 7.4. Written Objective Test

Criteria

Performance will be satisfactory when:

- 7.1. learner can use a metric ruler to measure lengths to the nearest millimeter
- 7.2. learner can efficiently recognize the relationship between millimeters and centimeters on a metric ruler, and measure lengths using either unit
- 7.3. learner can use a shop ruler (1/32nd inch precision) to measure lengths to the nearest 1/32nd of an inch, and mentally reduce any measurement to lowest terms
- 7.4. learner can read micrometers with 0.0001" precision to the nearest ten-thousandth of an inch
- 7.5. learner can use a metric brake drum micrometer to determine the diameter of a brake drum to the

- nearest tenth of a millimeter
- 7.6. learner can use an inch-based brake drum micrometer to determine the diameter of a brake drum to the nearest thousandth of an inch
- 7.7. learner can perform all calculations with at least 70% accuracy

Learning Objectives

- 7.a. Measure lengths of various parts using a steel pocket ruler to a precision of $\frac{1}{32}$ of an inch and 0.1 cm
- 7.b. Use a micrometer to measure engine parts, such as valve stems, to the nearest ten-thousandth (0.0001) of an inch
- 7.c. Use U.S. Standard and metric brake drum micrometers to measure brake drum diameters to the nearest thousandth (0.001) of an inch and to the nearest hundredth (0.01) of a centimeter

8. Determine the relationship between torque, horsepower, and mechanical drive systems.

Assessment Strategies

- 8.1. Skill Demonstration
- 8.2. Written Objective Test

Criteria

Performance will be satisfactory when:

- 8.1. learner can identify the driven and drive ratios in a gear-based power transfer, and determine the gear ratio of the pair, rounded correctly
- 8.2. learner can follow the powerflow through a manual transmission, determine the overall gear ratio for a given transmission configuration, and round the overall ratio correctly
- 8.3. learner can use the gear ratio of a gearset to determine the output speed, output torque, and output horsepower given the necessary input parameters
- 8.4. learner can calculate the gear ratio of a given planetary gearset configuration by using a planetary gear ratio table and the necessary gear tooth counts
- 8.5. learner can use the torque, force, lever-length relationship to calculate the third value with the other two are known, using proper rounding techniques and reporting answers with proper units
- 8.6. learner can interpret each part of a standard P-metric tire size and use that information to determine tire section width, sidewall height, and overall diameter in inches, millimeters and centimeters
- 8.7. learner can perform all calculations with at least 70% accuracy

Learning Objectives

- 8.a. Determine the gear ratio for a pair of gears and for gears in tandem, within a drive train
- 8.b. Analyze the effect on torque, RPM, and horsepower when power is transferred using a set of gears
- 8.c. Calculate the gear ratio for any planetary gearset configuration given gear tooth counts
- 8.d. Identify and compute the value of the missing element in a torque, force, lever relationship
- 8.e. Interpret the P-metric tire sizing system and use a given tire size to calculate width, sidewall height, and overall diameter

9. Apply ratio and proportion concepts to solve problems

Assessment Strategies

- 9.1. Skill Demonstration
- 9.2. Written Objective Test

Criteria

Performance will be satisfactory when:

- 9.1. learner uses decimal approximation and correct units to write a ratio as a unit rate
- 9.2. learner can perform any numeric or unit cancelling necessary to write a ratio in lowest terms
- 9.3. learner can solve proportions containing decimals using cross-multiplication and conventional rounding techniques
- 9.4. learner can solve proportions containing fractions by using proper fractional multiplication and division techniques
- 9.5. learner uses proportions to determine used and unused value of items carrying a pro-rated warranty, including tires and batteries, to the nearest cent
- 9.6. learner can perform all calculations with at least 70% accuracy

Learning Objectives

- 9.a. Write the ratio between given quantities as a unit rate and in lowest terms

- 9.b. Solve for the unknown quantity in a given proportion containing decimals
- 9.c. Solve for the unknown quantity in a given proportion containing fractions
- 9.d. Use proportions to calculate refund value on pro-rated items including tires and batteries

10. Apply percent concepts to solve problems

Assessment Strategies

- 10.1. Skill Demonstration
- 10.2. Written Objective Test

Criteria

Performance will be satisfactory when:

- 10.1. learner can convert between decimal numbers and percents by moving the decimal point appropriately
- 10.2. learner can convert between fractions and percents by dividing or treating percents as fractions appropriately
- 10.3. learner can identify base, rate, and amount in a percent problem, and use the $a = br$ relationship or percent proportions to solve for an unknown in such problems
- 10.4. learner can calculate the value of a percent discount, percent markup, sales tax, or any combination of these, and round the answer appropriately
- 10.5. learner can calculate the actual tolerance from a percent tolerance, and determine if a given measurement is within allowable range for a percent tolerance
- 10.6. learner can calculate axle weights based on percent weight distributions and total vehicle weight
- 10.7. learner can determine whether all cylinder pressures are within 15% of the highest cylinder pressure for a given engine
- 10.8. learner can perform all calculations with at least 70% accuracy

Learning Objectives

- 10.a. Convert between decimal, fraction, and percent form of a number
- 10.b. Identify the base, rate and amount within a percent application
- 10.c. Use proportions or decimal equivalents to solve problems involving percent markup, percent discount, and sales tax
- 10.d. Calculate the minimum and maximum values of an acceptable range given a nominal value and percent tolerance
- 10.e. Solve percent problems related to transportation trades including percent weight distribution and compression testing