# MA 15300 Student Learning Outcomes

The learning outcomes listed in the Purdue online catalog for MA 15300 are as follows:
1. To correctly perform algebraic operations, to solve algebraic equations of degree two, to perform operations with exponents and radicals.
2. To sketch graphs of certain polynomial, exponential and logarithmic functions.
3. To solve systems of equations and inequalities.

Additional learning outcomes are listed below.

***Relations and Function***
1. Determine if a relation represents $y$ as a function of $x$.
2. Use and interpret functional notation.

***The Average Rate of Change***
1. Find and interpret the average rate of change.
2. Represent the average rate of change on a graph as the slope of a segment.
3. Use the function notation for the average rate of change.

***Finding formulas of linear functions if given an initial value***
1. Use the average rate of change to determine if a function is linear.
2. Given the equation of a linear function, find and interpret its slope and axis intercepts and sketch its graph.
3. Find a linear model if given an initial value and an average rate of change.

***Finding formulas of linear functions if not given an initial value***
1. Find a linear model if given an initial value and an average rate of change.
2. Find a linear model if given any value (not necessarily its initial value) and an average rate of change.
3. Find a linear model if given any two points.
4. Determine when two lines are parallel and when they are perpendicular.
5. Determine the slope and equation of a horizontal line and a vertical line.
6. Construct linear models and find intersection points.

***Modeling with Linear Functions***
1. Determine the following geometric properties for linear functions from their equations:
   - when their $y$-intercepts are positive or negative
   - when they are increasing or decreasing (or neither)
2. Construct linear models and find intersection points to solve problems and make predictions.

***Input and Output***
1. Use a graph, table, or an equation to evaluate a function or find its input(s) given its output.
   - Review of algebraic operations, exponents, radicals and rational exponents, and fractional expressions.
2. Evaluate functions at given input.
3. Solve systems of equations and inequalities and interpret the results.

***Domain and Range***
1. Use a graph to report the domain and range of a function.
2. Report the domain and range of a function given the formula.
   - Review of algebraic operations, exponents, radicals and rational exponents, and fractional expressions.

***Composition of Functions***
1. Create a new functions by combining them with the operations of addition, subtraction, multiplication, and division.
2. Use function composition to create a new functions.
   - Review of algebraic operations, exponents, radicals and rational exponents, and fractional expressions.

***Inverse Functions***
1. Use notation for inverse functions given a graph, formula, table, or words.
2. Interpret expressions or equations which involve function notation and inverse function notation.
3. If given the formula for a function, find the formula of the inverse function.

***Concavity***
1. Determine the intervals of $x$ for which is increasing or decreasing.
2. Determine the intervals of $x$ for which is concave up or down.

***Exponential Growth and Decay***
1. Given a formula, get an annual growth rate (or decay rate), as well as an initial amount.
2. Given an annual growth rate (or decay rate) and an initial amount,
   a. write a formula $y = ab^x$ or
   b. know what $a$ and $b$ mean in the formula $y = ab^x$ or
   c. predict a future value of $y$ for some $x$ and given a value of $y$, find a value of $x$

***Finding Formulas of Exponential Functions and Comparing Linear and Exponential Functions***
1. Given some data (which is **not** an initial amount).
   a. write a formula $y = ab^x$ or
   b. know what $a$ and $b$ mean in the formula $y = ab^x$ or
   c. predict a future value of $y$ for some $x$ and given a value of $y$, find a value of $x$.
2. Compare linear and exponential functions and find their intersections points.

***Graphs of Exponential Functions and Horizontal Asymptotes***
1. Determine what $a$ and $b$ mean in the formula $y = ab^x$.
2. Describe the general shape, concavity, domain, range, and asymptotes of the function $y = ab^x$.

***Compound Interest***
1. Use the compound interest formula $A = P(1 + r/n)^{nt}$ appropriately and relate it to the growth formula $A = P(1 + r)^t$.
2. Relate the compound interest formula $A = P(1 + r/n)^{nt}$ to the growth formula $A = P(1 + r)^t$ and $A = Pe^{rt}$.
3. Use the compound interest formula $A = P(1 + r/n)^{nt}$ or $A = Pe^{rt}$. Find $A$, $P$, or $t$ if given the remaining parameters.

***What is a Logarithm?***
1. Rewrite an equation in exponential form into logarithmic form and vice versa.
2. Find the value of a logarithm written to any base, as well as common and natural logarithms.
3. Use the inverse properties of logarithms

***Properties of Logarithms***
1. Use the inverse properties of logarithms
2. Rewrite a logarithmic expression using properties of logs

***Using Inverse Properties to Solve Equations for Exact Answers***
1. Use inverse properties to find both exact and approximate solutions to *exponential* equations.
2. Use inverse properties to find both exact and approximate solutions to *logarithmic* equations

***Doubling Time, Tripling Time, and Half-Life***
1. Given a function which models exponential growth, find the doubling or tripling time and the percent growth per unit time period.
2. If given the doubling time or percent rate over a given time period, write a possible formula
3. Given a function which models exponential decay, find half-life and the percent loss per unit.
4. If given the half-life or percent rate over a given time period, write a possible formula

***The Graph of the Logarithm and Vertical Asymptotes***
1. Report the concavity, domain, range, asymptotes, intercepts of the graph of $y = \log x$ or $y = \ln x$.
2 .Report the concavity, domain, range, asymptotes, intercepts of the graph of $y = \log_b x$.

***Logs as Re-Expressions of Large or Small Quantities***
1. Use the logarithm to re-express the intensity of an earthquake as a Richter scale magnitude and compare earthquake intensities.
2. Use the relationship between pH and the hydrogen ion concentration $[H^+]$ to find $[H^+]$ if given the pH.
3. Use the relationship between pH and the hydrogen ion concentration $[H^+]$ to find pH if given $[H^+]$.

**Translation of Functions**
1. Understand vertical shifts of a function as an *outside additive* change to the function rule.
2. Understand horizontal shifts of a function as an *inside additive* change to the function rule.
3. Given the graph and formula of a parent function and a transformation, find the graph and formula of its child graph.
4. Given the graph and formula of a parent function and its child graph, describe the transformation and find its formula.

***Horizontal and Vertical Reflections***
1. Graph a function which has been vertically reflected (about the $x$-axis) or horizontally reflected (about the $y$-axis) .
2. When multiplying a function formula by $-1$, determine how this affects the graph:
   - relate an outside change to the function formula to a change in the outputs.
   - relate an inside change to the function formula to a change in the inputs.
3. Write the formula of a vertical or horizontal reflection of a function if given its graph or sketch a graph if given its formula.
4. Combine reflections with shift transformations.
5. Given the graph and formula of a parent function and a transformation, find the graph and formula of its child graph.
6. Given the graph and formula of a parent function and its child graph, describe the transformation and find its formula.

***The Symmetry of Even and Odd Functions***
1. Identify whether a function is odd, even, or neither by looking at its graph, equation or table.
2. If given that a function is odd or even and a point on its graph, determine another point.

**Vertical Stretches and Compressions**
1. Graph a function which has been vertically stretched or vertically compressed.
2. If $c$ is any positive number, determine how the graph of $y = cf(x)$ affects the graph of $y = f(x)$ for $c < 1$ and $c > 1$.
3. Write the formula of a vertical stretch of a function if given its graph or sketch a graph if given its formula.
4. Write the formula of a vertical compression of a function if given its graph or sketch a graph if given its formula.

**Quadratic Functions - Three Ways to Write the Formula**
1. Determine the zeros of a quadratic function.
   - Review of factoring.
2. Write the formula of a quadratic function in vertex form, factored form, or expanded (standard) form.

**Applications of Quadratic Functions**
1. Determine the $y$-intercept and the axis of symmetry of a quadratic function.
2. Solve quadratic equations algebraically, graphically, and through the use of the table.
3. Find and interpret the zeros of a quadratic function using a variety of methods.
4. Use a graphing calculator to graph a function in an appropriate viewing window. Use built-in calculator features such as an intersection point finder, maximum/minimum finder, or zero finder to solve problems.

***Power Functions – Shapes***
1. Identify if a function is a power function $y = kx^p$. If so, report $k$ and $p$.
2. Sketch a rough graph of a power function and report its properties such as domain, range, asymptotes, and end behavior.

***Finding the Formula of a Power Function***
1. Find the formula for a power function $f(x) = kx^p$ if given that it passes through two points $(a, f(a))$ and $(b, f(b))$, where $a = 1$.
2. Find the formula for a power function $f(x) = kx^p$ if given that it passes through two points $(a, f(a))$ and $(b, f(b))$, where $a \neq 1$.

***Introduction to Polynomials and Long Run Behavior***
1. Identify the degree, leading term, leading coefficient, and long-run behavior of a polynomial if given in expanded or factored form.
2. Use the leading term of a polynomial to report its long run behavior.

***Short Run Behavior of Polynomials***
1. Use factoring to find the zeros of a polynomial.
2. Determine the zeros of a polynomial if given its equation in expanded or factored form. If necessary, use a graphing calculator or try to factor.
3. Rewrite a polynomial function in expanded form in factored form by using the zeros and the multiplicity (or behavior of the function at each zero)
4. Find the formula of a polynomial function if given its graph.

***Introduction to Rational Functions and Long Run Behavior***

1. Find the power function model of a rational function.
2. Use the power function model of a rational function to determine its long run behavior.
3. Report horizontal asymptotes of a rational function, if they exist.

**Asymptotes and Intercepts**

1. Find the power function model of a rational function.
2. Use the power function model of a rational function to determine its long run behavior.
3. Report the horizontal asymptote of a rational function, if it exists.
4. Report any vertical asymptotes of a rational function.
5. Report any intercepts of a rational function.

***Finding the Formula of a Rational Function***

1. Report the intercepts and asymptotes of a rational function.
2. Use a shift transformation of $y = k/x^p$ to write the formula of a rational function as $y = k/(x - a)^p + b$.
3. Use long run and short run behavior to write the formula of a rational function as $y = p(x)/q(x)$.