Indiana Academic Standards for Mathematics – Pre-Calculus
Adopted April 2014 – Standards Resource Guide Document

This Teacher Resource Guide has been developed to provide supporting materials to help educators successfully implement the Indiana Academic Standards for Pre-Calculus Mathematics – Adopted April 2014. These resources are provided to help you in your work to ensure all students meet the rigorous learning expectations set by the Academic Standards. Use of these resources is optional – teachers should decide which resource will work best in their school for their students.

This resource document is a living document and will be frequently updated.
Please send any suggested links and report broken links to:
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The examples in this document are for illustrative purposes only, to promote a base of clarity and common understanding. Each example illustrates a standard but please note that examples are not intended to limit interpretation or classroom applications of the standards.

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GOOD WEBSITES FOR MATHEMATICS:
http://nlvm.usu.edu/en/nav/vlibrary.html
http://www.math.hope.edu/swanson/methods/applets.html
http://learnzillion.com
http://illuminations.nctm.org
https://teacher.desmos.com
http://illustrativemathematics.org
http://www.insidemathematics.org
https://www.khanacademy.org/
https://www.teachingchannel.org/
http://map.mathshell.org/materials/index.php
https://www.istemnetwork.org/index.cfm
http://www.azed.gov/azccrs/mathstandards/

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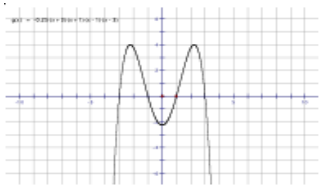
Polar Coordinates and Complex Numbers				
MA.PC.PCN.1:	PC.PCN.1: Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.	modulus: the absolute value | a + bi | = $\sqrt{a^2+b^2}$	Find the distance between 2 – 5i and –1 + 4i $\sqrt{(2--1)^2+(-5-4)^2}=\sqrt{90}$	http://www.mathworksheetsland.com/hsnumbersquan/12calcdist/lesson.pdf https://www.illustrativemathematics.org/illustrations/1094
MA.PC.PCN.2:	PC.PCN.2: Understand and use complex numbers, including real and imaginary numbers, on the complex plane in rectangular and polar form, and explain why the rectangular and polar forms of a given complex number represent the same number.		Graph (-2,2) on a rectangular coordinate system. Convert it to polar form and graph on a polar grid. Rectangular (x,y) / Polar (r,ϑ) / Complex x + yi (a + bi) / Trig Form $r(\cos\vartheta + i\sin\vartheta)$ Ex1. (-2, 2) Ex2. $\left(3,\frac{\pi}{3}\right)$ Ex3. $-1+i\sqrt{3}$ Ex4. $4\left(\cos\frac{11\pi}{6}+i\sin\frac{11\pi}{6}\right)$ or $4cis\frac{11\pi}{6}$	http://faculty.tarleton.edu/jgresham/Math%20109/notes_polar_complex_numbers.pdf
MA.PC.PCN.3:	PC.PCN.3: Understand and use addition, subtraction, multiplication, and conjugation of complex numbers, including real and imaginary numbers, on the complex plane in rectangular and polar form.		Given: z = 2 – 3i and w = -4 + 5i Find z + w, z – w, zw, conjugate of z	http://www.shmoop.com/common-core-standards/ccss-hs-n-cn-5.html https://www.illustrativemathematics.org/illustrations/1659
MA.PC.PCN.4:	PC.PCN.4: State, prove, and use DeMoivre's Theorem.	Powers – DeMoivre's Theorem $z_1^n = r^n(\cos(n\vartheta)+i\sin(n\vartheta))$	Find (2 - 2i) ^ 5	http://math.ucsd.edu/~wgarner/math4c/textbook/chapter9/demoivre_theorem.htm
Functions				
MA.PC.F.1:	PC.F.1: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.		 x-intercepts_____ y-intercept_____ Local maximum(s)_____ Local minimum(s)_____ Intervals of increasing_____ Intervals of decreasing_____	https://www.illustrativemathematics.org/illustrations/1415

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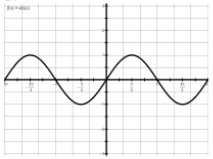
MA.PC.F.2:	PC.F.2: Find linear models by using median fit and least squares regression methods. Decide which among several linear models gives a better fit. Interpret the slope and intercept in terms of the original context.		Percent of fatalities due to drunk driving Year L1 / Percent of fatalities due to drunk driving L2 1982 57% 1985 51% 1988 50% 1991 47% 1994 40% 1997 38% 1999 37% a) Equation:_____ r=_____ b) Slope =_____ What does it mean in the context of the problem? c) In which year were there 45% of fatalities due to drunk driving? d) Assuming the trend continued, what would be the % of fatalities during the 2013 year?	
MA.PC.F.3:	PC.F.3: Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.		Write a formula for the given sequence of values n: 1, 2, 3, 4 F(n): 10, 16, 22, 28	https://learnzillion.com/lessons/3364-understand-sequences-as-functions
MA.PC.F.4:	PC.F.4: Determine if a graph or table has an inverse, and justify if the inverse is a function, relation, or neither. Identify the values of an inverse function/relation from a graph or a table, given that the function has an inverse. Derive the inverse equation from the values of the inverse.		Which of the following functions has an inverse. For each of those having an inverse, find its inverse in like format (as a table, function or graph). 1. 2. g(x)=2^x x / F(x): -2 4; -1 1; 0 0; 1 1 3. 	http://www.sde.ct.gov/sde/lib/sde/pdf/curriculum/p69_possiblesentences_grades10-12_algebra2.pdf
MA.PC.F.5:	PC.F.5: Produce an invertible function from a non-invertible function by restricting the domain.		Determine an appropriate domain for which the function f(x) = x^2 will have an inverse.	http://www.shmoop.com/common-core-standards/ccss-hs-f-bf-4d.html http://www.mathsisfun.com/sets/function-inverse.html
MA.PC.F.6:	PC.F.6: Describe the effect on the graph of replacing f(x) by f(x) + k, k f(x),f(kx), and f(x + k) for specific values of k (both positive and negative). Find the value of k given the graph f(x) and the graph of f(x) + k, k f(x), f(kx), or f(x + k). Experiment with cases and illustrate an explanation of the effects on the graph using technology. Recognize even and odd functions from their graphs and algebraic expressions.		Given an even function y = x^2, which of the following is still even? y = x^2 – 3 y = (x – 3)^2 y = -4x^2 y = 2(x + 1)^2 + 4	http://www.virtualnerd.com/common-core/hsf-functions/HSF-BF-building-functions/B/3

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MA.PC.F.7:	PC.F.7: Decide if a function is continuous at a point. Find the types of discontinuities of a function and relate them to finding limits of a function. Use the concept of limits to describe discontinuity and end-behavior of the function.		$f(x) = \frac{2x-5}{x+2}$ y-int _____ x-int _____ VA _____ x | f(x) -2.1 -1.9 Behavior near VA $\lim_{x \to -2^-} f(x) =$ _____ $\lim_{x \to -2^+} f(x) =$ _____ EBM _____ $\lim_{x \to -\infty} f(x) =$ _____ $\lim_{x \to \infty} f(x) =$ _____	https://www.math.ucdavis.edu/~kouba/CalcOneDIRECTORY/continuitydirectory/Continuity.html
MA.PC.F.8:	PC.F.8: Define arithmetic and geometric sequences recursively. Use a variety of recursion equations to describe a function. Model and solve word problems involving applications of sequences and series, interpret the solutions and determine whether the solutions are reasonable.		Write a recursive and explicit formula for 45, 39, 33, 27, ...	http://home.windstream.net/okrebs/page131.html
MA.PC.F.9:	PC.F.9: Use iteration and recursion as tools to represent, analyze, and solve problems involving sequential change.		Suppose you receive a $2000 each year and decide to save it in an account earning 3% annual interest. Determine the amount of money in the account at the end of the first, 2nd, 3rd year. Write a recursive expression for determining the amount of money in the account. Determine the number of squares represented in each of the other diagrams.  n=1 n=2 n=3 n=4 s=1 s=1 + 4 = 5 s=_____ s=_____ Find the number of squares in a 5 by 5 square. Write a rule or formula for finding the number of squares in an n by n square.	http://www.wmich.edu/cpmp/2nd/unitsamples/c3u7intro.html
MA.PC.F.10:	PC.F.10: Describe the concept of the limit of a sequence and a limit of a function. Decide whether simple sequences converge or diverge. Recognize an infinite series as the limit of a sequence of partial sums.		List the first several terms of the series Does the sequence of numbers have a limit? Is the sum possible? If so find the sum. $\sum_{n=1}^{\infty} \left(\frac{1}{2}\right)^{n-1}$	https://www.khanacademy.org/math/integral-calculus/sequences_series_approx_calc/seq-conv-diverg/v/definition-of-limit-of-a-sequence-and-sequence-convergence

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Quadratic, Polynomial, and Rational Equations and Functions				
MA.PC.QPR.1:	PC.QPR.1: Use the method of completing the square to transform any quadratic equation into an equation of the form (x – p)^2 = q that has the same solutions. Derive the quadratic formula from this form.		Change $y = x^2 - 2x - 3$ into $y = (x-h)^2 + k$ form By completing the square.	http://www.mathsisfun.com/algebra/completing-square.html http://www.purplemath.com/modules/sqrquad2.htm
MA.PC.QPR.2:	PC.QPR.2: Graph rational functions with and without technology. Identify and describe features such as intercepts, domain and range, and asymptotic and end behavior.		Consider the function $f(x) = \frac{x^2+4x-12}{x^2-9}$ 1. Find y-intercepts 2. Find x-intercepts 3. Find vertical asymptotes 4. Find horizontal asymptote. 5. Use limit notation to express the behavior near x = -3 6. Use limit notation to express the behavior at $x \to \infty$ 7. Sketch the graph:	http://tutorial.math.lamar.edu/Classes/Alg/GraphRationalFcns.aspx http://www.purplemath.com/modules/grphrtnl.htm
MA.PC.QPR.3:	PC.QPR.3: Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).		Remainder Theorem $f(x) = 3x^3 + 8x^2 + 5x - 7$ Compare: f(-2) to Dividing by (x + 2)	http://www.mathsisfun.com/algebra/polynomials-remainder-factor.html http://www.purplemath.com/modules/remaindr.htm
MA.PC.QPR.4:	PC.QPR.4: Understand the Fundamental Theorem of Algebra. Find a polynomial function of lowest degree with real coefficients when given its roots.		Write a polynomial of smallest degree having integer coefficients that has the given roots. First write in factored form and then expand Use the sum/product rule to help in the expansion $-2, \quad 3, \quad 1-i,$ _____	http://www.cut-the-knot.org/do_you_know/fundamental2.shtml http://www.mathsisfun.com/algebra/fundamental-theorem-algebra.html
Exponential and Logarithmic Equations and Functions				
MA.PC.EL.1:	PC.EL.1: Use the definition of logarithms to convert logarithms from one base to another and prove simple laws of logarithms.		Compare the following. 1. a) $\log_2(8 \cdot 4) =$ b) $\log_2 8 \cdot \log_2 4 =$ c) $\log_2 8 + \log_2 4 =$ $\log_2(32) =$ ___ ___•___ =___ ___+___=___ So $\log_b 8 \cdot 4 = \log_b$ $\log_b$ And in general $\log_b MN =$ Product Property	http://www.purplemath.com/modules/logrules5.htm
MA.PC.EL.2:	PC.EL.2: Use the laws of logarithms to simplify logarithmic expressions and find their approximate values.		Use properties of logs to solve. $\log 5x + \log(x-1) = 2$	http://home.windstream.net/okrebs/page56.html
MA.PC.EL.3:	PC.EL.3: Graph and solve real-world and other mathematical problems that can be modeled using exponential and logarithmic equations and inequalities; interpret the solution and determine whether it is reasonable.		In the 2010 census the population of Fishers was 77,000. In 2012 it was 82,000. If we assume this growth is exponential. Determine when the population will reach 100,000.	http://cims.nyu.edu/~kiryl/Precalculus/Section_4.6-Modeling%20with%20Exponential%20and%20Logarithmic%20Functions/Modeling%20with%20Exponential%20and%20Logarithmic%20Functions.pdf
MA.PC.EL.4:	PC.EL.4: Use technology to find a quadratic, exponential, logarithmic, or power function that models a relationship for a bivariate data set to make predictions; compute (using technology) and interpret the correlation coefficient.		Create a scatterplot of the data. Use the scatter plot To determine whether an exponential function or a Logarithmic function is the best choice for modeling. Age at Death | Health care savings needed For care during retirement 80 | $219,000 85 | $307,000 90 | $409,000 95 | $524,000 100 | $656,000	http://www.dlt.ncssm.edu/AFM/bygoal.htm

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Parametric Equations				
MA.PC.PE.1:	PC.PE.1: Convert between a pair of parametric equations and an equation in x and y. Model and solve problems using parametric equations.		James Bond is starting to cross a 300 ft long bridge and Dr. No is trying to stop him. Suppose Dr. No drops a bomb from his helicopter hovering at a point 250 ft past the start of the 300 ft bridge and 200 ft up in the air, while James' car is moving at a velocity of 60 ft per second at a height of 20 feet above the water. Will Dr. No successfully destroy the bridge before James can cross it? a) Write parametric equations for Dr. No. Horizontal component: xt1=_____ Vertical component(s): yt1=_____ b) Write parametric equations for James Bond. Horizontal component: xt2=_____ Vertical component(s): yt2=_____ c) State the t min, t max and tstep _____ d) State the window [_____] [_____] Conclusion:	http://www.youtube.com/watch?v=tW6N7DFTvrM http://sites.csn.edu/istewart/mathweb/Math127/para_equ/para_equ.htm
MA.PC.PE.2:	PC.PE.2: Analyze planar curves, including those given in parametric form.		Mode: Parametric Degree 1. Window: T: [0,360,3] x:[-4.7,4.7] y:[-3.1,3.1] 2. Graph : $x_{1t} = \cos T$, $y_{1t} = \sin T$ 3. Graph: $x_{1t} = 3\cos T$, $y_{1t} = 3\sin T$ 4. Graph: $x_{1t} = 4\cos T$, $y_{1t} = 6\sin T$ in [-9.4,9.4] [-6.2,6,2] 5. Summarize: _____	http://centralmathteacher.wikispaces.com/Analysis+of+planar+curves+given+in+parametric+form,+polar+form,+and+vector+form,+including+velocity+and+acceleration+vectors.