Function Features

A function f
is concave up if…

Function Features

A function f
is concave down if…

Function Features

A function f
is increasing on an interval if…

Function Features

A function f
is decreasing on an interval if…

Function Features

Average rate of change of f on the interval $[a, b]$

Function Features

The slope of a function at any given point gives…

Function Features

A positive rate of change indicates that the function output is…

Function Features

A negative rate of change indicates that the function output is…

Function Features

Point of inflection

Function Features

One-to-one function

The rates of change of f are decreasing	The rates of change of f are increasing
As the input values increase, the output values always decrease. OR For all a and b in the interval, if $a < b$, then $f(a) > f(b)$.	As the input values increase, the output values always increase. OR For all a and b in the interval, if $a < b$, then $f(a) < f(b)$.
The rate of change of the function at that input	$\frac{f(b) - f(a)}{b - a}$
Decreasing	Increasing
Function where each input has a unique output (no repeated outputs)	Point on the graph of a function where the concavity changes, indicating a maximum or minimum rate of change

Function Features

A relative minimum occurs when a function f…

Function Features

A relative maximum occurs when a function f…

Function Features

Absolute minimum

Function Features

Absolute maximum

Function Features

Multiplicity

Function Features

A polynomial of degree n has…

Function Features

If $x = a$ is a real zero of a polynomial with an odd multiplicity, then…

Function Features

If $x = a$ is a real zero of a polynomial with an even multiplicity, then…

Function Features

Odd function

Function Features

Even function

Changes from increasing to decreasing	Changes from decreasing to increasing
The greatest output of a function	The least output of a function
• Exactly n complex zeros (real or imaginary) • Constant nth differences • At most $n-1$ extrema	The number of times a factor occurs in a polynomial function
The graph of the polynomial is tangent to the x-axis at $x = a$.	The graph of the polynomial passes through the x-axis at $x = a$.
$f(-x) = f(x)$	$f(-x) = -f(x)$

Function Features

End behavior of a polynomial f with an even degree and a negative leading coefficient

Function Features

End behavior of a polynomial f with an odd degree and a positive leading coefficient

Function Features

End behavior of a polynomial f with an odd degree and a negative leading coefficient

Function Features

End behavior of a polynomial f with an even degree and a positive leading coefficient

Function Features

If a rational function, f, has a horizontal asymptote at $y = b$, then…

Function Features

To determine the end behavior of a rational function…

Function Features

A rational function has a zero at $x = a$ if…

Function Features

A rational function has a hole at $x = a$ if…

Function Features

A rational function has a vertical asymptote at $x = a$ if…

Function Features

For rational functions, a slant asymptote occurs when…

$\lim_{x \to \infty} f(x) = \infty$ $\lim_{x \to -\infty} f(x) = -\infty$	$\lim_{x \to \infty} f(x) = -\infty$ $\lim_{x \to -\infty} f(x) = -\infty$
$\lim_{x \to \infty} f(x) = \infty$ $\lim_{x \to -\infty} f(x) = \infty$	$\lim_{x \to \infty} f(x) = -\infty$ $\lim_{x \to -\infty} f(x) = \infty$
Analyze the ratio of leading terms	The ratio of leading terms is a constant, b, $\lim_{x \to \infty} f(x) = b$, and $\lim_{x \to -\infty} f(x) = b$
$x = a$ is a zero of the numerator AND the denominator	$x = a$ is a zero of the numerator but NOT the denominator
The degree of the numerator is exactly one more than the degree of the denominator	$x = a$ is a zero of the denominator but NOT the numerator

Function Features

If a rational function, f, has a vertical asymptote at $x = a$, then $\lim_{x \to a^-} f(x) =$ ____ and $\lim_{x \to a^+} f(x) =$ _____.

Function Features

If a rational function, f, has a hole at (a, L) then $\lim_{x \to a^-} f(x) = \lim_{x \to a^+} f(x) =$ ___.

Function Features

A function $f(x) = ab^x$ demonstrates exponential growth if…

Function Features

A function $f(x) = ab^x$ demonstrates exponential decay if…

Function Features

Key features of $y = \log_b x$ where $b > 1$

Function Features

Key features of $y = b^x$ where $b > 1$

Properties and Identities

$b^{x+c} =$

Properties and Identities

$b^{x-c} =$

Properties and Identities

$e^{a \ln b} =$

Properties and Identities

$\log_b(1) =$

L	$\pm\infty$; $\pm\infty$
$0 < b < 1$	$b > 1$
• Domain: all real numbers • Range: $y > 0$ • Horizontal asymptote at $y = 0$ • Increasing and concave up over entire domain	• Domain: $x > 0$ • Range: all real numbers • Vertical asymptote at $x = 0$ • Increasing and concave down over entire domain
$\frac{b^x}{b^c}$	$b^x \cdot b^c$
0	b^a

Properties and Identities

$$\log_b(b) =$$

Properties and Identities

$$\log_b(mn)$$

Properties and Identities

$$\log_b\left(\frac{m}{n}\right)$$

Properties and Identities

$$\log_b m^k$$

Properties and Identities

Pythagorean Identities

Properties and Identities

$$\sec\theta =$$
$$\csc\theta =$$
$$\cot\theta =$$

Properties and Identities

$$\cos(\alpha \pm \theta)$$

Properties and Identities

$$\sin(\alpha \pm \theta)$$

Properties and Identities

$$\cos(2\theta)$$

Properties and Identities

$$\sin(2\theta)$$

$\log_b m + \log_b n$	1
$k \log_b m$	$\log_b m - \log_b n$
$\dfrac{1}{\cos\theta}$ $\dfrac{1}{\sin\theta}$ $\dfrac{1}{\tan\theta} = \dfrac{\cos\theta}{\sin\theta}$	$\sin^2\theta + \cos^2\theta = 1$ $1 + \cot^2\theta = \csc^2\theta$ $\tan^2\theta + 1 = \sec^2\theta$
$\sin\alpha\cos\theta \pm \sin\theta\cos\alpha$	$\cos\alpha\cos\theta \mp \sin\alpha\sin\theta$
$2\sin\theta\cos\theta$	$\cos^2\theta - \sin^2\theta$ $= 2\cos^2\theta - 1$ $= 1 - 2\sin^2\theta$

Polar Functions Given (x, y) in Cartesian coordinates, determine polar coordinates, (r, θ)	Polar Functions Given (r, θ) in polar coordinates, determine Cartesian coordinates, (x, y)
Polar Functions A polar function $r = f(\theta)$ is increasing if…	Polar Functions A polar function $r = f(\theta)$ is decreasing if…
Polar functions The distance between a point on a polar function $r = f(\theta)$ and the origin is increasing if…	Polar functions The distance between a point on a polar function $r = f(\theta)$ and the origin is decreasing if…
Describing Growth in Functions A function is linear if over equal-length input intervals, output values ______.	Describing Growth in Functions A function is quadratic if over equal-length input intervals, output values ______.
Describing Growth in Functions A function is exponential if as input values change _____, output values change _____.	Describing Growth in Functions A function is logarithmic if as input values change _____, output values change ______.

$x = r\cos\theta$ $y = r\sin\theta$	$r = \sqrt{x^2 + y^2}$ $\theta = \tan^{-1}\left(\frac{y}{x}\right)$ (*Add π if angle is in Q2 or Q3)
As θ increases, r decreases.	As θ increases, r increases.
r is positive and decreasing or r is negative and increasing. ($\lvert r \rvert$ is decreasing)	r is positive and increasing or r is negative and decreasing. ($\lvert r \rvert$ is increasing)
Change by a constant second difference.	Change by a constant amount.
multiplicatively; additively	additively; multiplicatively

Describing Growth in Functions

The average rates of change of a linear function are…

Describing Growth in Functions

The average rates of change of a quadratic function…

Trig Functions

$\tan\theta$ gives the _______ of the terminal ray of θ.

Trig Functions

Domain and range of $y = \arcsin x$

Trig Functions

Domain and range of $y = \arccos x$

Trig Functions

Domain and range of $y = \arctan x$

Trig Functions

$f(x) = \tan x$ has vertical asymptotes at…

Trig Functions

$f(x) = \cot x$ has vertical asymptotes at …

Trig Functions

Determine the amplitude, period, midline, and phase shift of $f(x) = a\sin\big(b(x-c)\big) + d$

Trig Functions

$y = \tan(bx)$ has a period of…

Are changing at a constant rate OR follow a linear pattern	Constant
Domain: $[-1,1]$ Range: $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$	Slope
Domain: $(-\infty, \infty)$ Range: $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$	Domain: $[-1,1]$ Range: $[0, \pi]$
$x = \pi k$, where k is an integer	$x = \frac{\pi}{2} + \pi k$, where k is an integer
$\frac{\pi}{b}$	Amplitude = $\lvert a \rvert$ Period = $\frac{2\pi}{b}$ Midline: $y = d$ Phase shift: c units to the right

Trig Functions

Key features of
$y = \sin x$

Trig Functions

Key features of
$y = \cos x$

Transformations

$f(x) + c$

Transformations

$f(x - c)$

Transformations

$cf(x)$

Transformations

$f(cx)$

Transformations

$-f(x)$

Transformations

$f(-x)$

Miscellaneous

Pascal's Triangle

Miscellaneous

What does
the constant e
represent?

• Domain: all real numbers • Range: [–1, 1] • Period: 2π • Amplitude: 1 • Midline: $y = 0$ • Passes through (0, 1)	• Domain: all real numbers • Range: [–1, 1] • Period: 2π • Amplitude: 1 • Midline: $y = 0$ • Passes through (0, 0)
Horizontal translation c units to the right if $c > 0$ or c units to the left if $c < 0$	Vertical translation c units up if $c > 0$ or c units down if $c < 0$
Horizontal dilation by a factor of $\frac{1}{c}$	Vertical dilation by a factor of c
Reflection over the y-axis	Reflection over the x-axis
The base rate of growth for all continually growing processes $e \approx 2.718$	1 1 1 1 2 1 1 3 3 1 1 4 6 4 1 1 5 10 10 5 1 1 6 15 20 15 6 1 1 7 21 35 35 21 7 1

Miscellaneous A positive residual indicates that the predicted value is an ____________.	Miscellaneous A negative residual indicates that the predicted value is an ____________.
Miscellaneous Explicit rule for nth term of a geometric sequence given common ratio r, and the a_k term	Miscellaneous Explicit rule for nth term of an arithmetic sequence given common difference d, and the a_k term
Miscellaneous Residual	Miscellaneous A model is considered appropriate for a data set if the residual plot…
Miscellaneous Error (in a model)	Miscellaneous f and g are inverse functions if…
Miscellaneous If the y-axis is logarithmically scaled, then…	Miscellaneous In a semi-log plot where the y-axis is logarithmically scaled, exponential functions will appear

Overestimate	Underestimate
$a_n = a_k + d(n - k)$	$a_n = a_k \cdot r^{n-k}$
Appears without pattern	Actual value – Predicted value
$f(g(x)) = g(f(x)) = x$	Predicted value – Actual value
linear	Equal-sized increments on the y-axis represent proportional changes in the output variable