

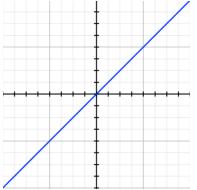
# LEARN

## Tutoring Services

### Twelve Basic Functions

Below are the graphs of twelve functions along with domain, range, continuity, increasing/decreasing intervals, symmetry, boundedness, extrema, asymptotes and end behavior. Also please note that  $\mathbb{Z}$  is the set of integers.

$$f(x) = x$$


**Identity Function**

Domain:  $(-\infty, \infty)$  Range:  $(-\infty, \infty)$

Continuous

Increasing:  $(-\infty, \infty)$  Decreasing: None

Symmetry: origin (odd function)

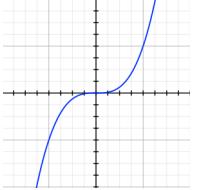
Not bounded

Extrema: None

H.A.: None V.A.: None

End behavior:  $\lim_{x \rightarrow -\infty} f(x) = -\infty$   $\lim_{x \rightarrow \infty} f(x) = \infty$

$$f(x) = x^3$$


**Cubing Function**

Domain:  $(-\infty, \infty)$  Range:  $(-\infty, \infty)$

Continuous

Increasing:  $(-\infty, \infty)$  Decreasing: None

Symmetry: origin (odd function)

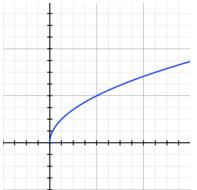
Not bounded

Extrema: None

H.A.: None V.A.: None

End behavior:  $\lim_{x \rightarrow -\infty} f(x) = -\infty$   $\lim_{x \rightarrow \infty} f(x) = \infty$

$$f(x) = \sqrt{x}$$


**Square Root Function**

Domain:  $[0, \infty)$  Range:  $[0, \infty)$

Continuous

Increasing:  $[0, \infty)$  Decreasing: None

Symmetry: None

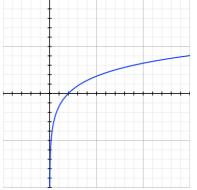
Bounded below

Extrema: Absolute minimum at  $(0,0)$

H.A.: None V.A.: None

End behavior:  $\lim_{x \rightarrow -\infty} f(x)$  Does Not Exist  $\lim_{x \rightarrow \infty} f(x) = \infty$

$$f(x) = \ln(x)$$


**Natural Logarithm Function**

Domain:  $(0, \infty)$  Range:  $(-\infty, \infty)$

Continuous

Increasing:  $(0, \infty)$  Decreasing: None

Symmetry: None

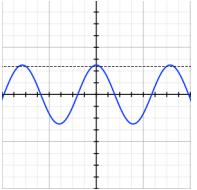
Not bounded

Extrema: None

H.A.: None V.A.:  $x = 0$

End behavior:  $\lim_{x \rightarrow -\infty} f(x)$  Does Not Exist  $\lim_{x \rightarrow \infty} f(x) = \infty$

$$f(x) = \cos(x)$$


**Cosine Function**

Domain:  $(-\infty, \infty)$  Range:  $[-1, 1]$

Continuous

Increasing:  $[\pi + 2\pi n, 2\pi + 2\pi n], n \in \mathbb{Z}$

Decreasing:  $[2\pi n, \pi + 2\pi n], n \in \mathbb{Z}$

Symmetry: y-axis (even function)

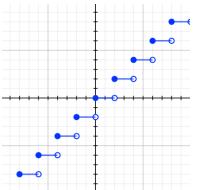
Bounded above and below

Extrema: minimum at  $x = \pi + 2\pi n, n \in \mathbb{Z}$

maximum at  $x = 2\pi n, n \in \mathbb{Z}$

End behavior: Oscillates between -1 and 1

$$f(x) = \text{int}(x)$$


**Greatest Integer Function**

Domain:  $(-\infty, \infty)$  Range:  $\mathbb{Z}$

Not continuous

Constant on the interval  $[n, n+1), n \in \mathbb{Z}$

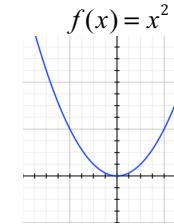
Symmetry: None

Not bounded

Extrema: None

H.A.: None V.A.: None

End behavior:  $\lim_{x \rightarrow -\infty} f(x) = -\infty$   $\lim_{x \rightarrow \infty} f(x) = \infty$


**Squaring Function**

Domain:  $(-\infty, \infty)$  Range:  $[0, \infty)$

Continuous

Increasing:  $[0, \infty)$  Decreasing:  $(-\infty, 0]$

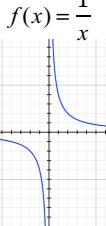
Symmetry: y-axis (even function)

Bounded below

Extrema: Absolute minimum at  $(0,0)$

H.A.: None V.A.: None

End behavior:  $\lim_{x \rightarrow -\infty} f(x) = \infty$   $\lim_{x \rightarrow \infty} f(x) = \infty$


**Reciprocal Function**

Domain:  $(-\infty, 0) \cup (0, \infty)$  Range:  $(-\infty, 0) \cup (0, \infty)$

Not Continuous

Increasing: None Decreasing:  $(-\infty, 0) \cup (0, \infty)$

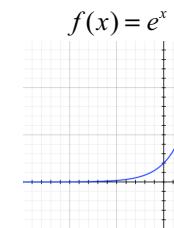
Symmetry: origin (odd function)

Not bounded

Extrema: None

H.A.:  $y = 0$  V.A.:  $x = 0$

End behavior:  $\lim_{x \rightarrow -\infty} f(x) = 0$   $\lim_{x \rightarrow \infty} f(x) = 0$


**Exponential Function**

Domain:  $(-\infty, \infty)$  Range:  $(0, \infty)$

Continuous

Increasing:  $(-\infty, \infty)$  Decreasing: None

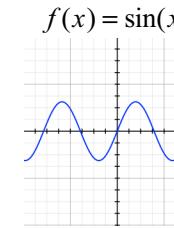
Symmetry: None

Bounded below

Extrema: None

H.A.:  $y = 0$  V.A.: None

End behavior:  $\lim_{x \rightarrow -\infty} f(x) = 0$   $\lim_{x \rightarrow \infty} f(x) = \infty$


**Sine Function**

Domain:  $(-\infty, \infty)$  Range:  $[-1, 1]$

Continuous

Increasing:  $[-\frac{\pi}{2} + 2\pi n, \frac{\pi}{2} + 2\pi n], n \in \mathbb{Z}$  Decreasing:  $[\frac{\pi}{2} + 2\pi n, \frac{3\pi}{2} + 2\pi n], n \in \mathbb{Z}$

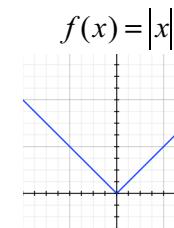
Symmetry: origin (odd function)

Bounded above and below

Extrema: minimum at  $x = -\frac{\pi}{2} + 2\pi n, n \in \mathbb{Z}$

maximum at  $x = \frac{\pi}{2} + 2\pi n, n \in \mathbb{Z}$

End behavior: Oscillates between -1 and 1



$$f(x) = |x|$$

**Absolute Value Function**

Domain:  $(-\infty, \infty)$  Range:  $[0, \infty)$

Continuous

Increasing:  $[0, \infty)$  Decreasing:  $(-\infty, 0]$

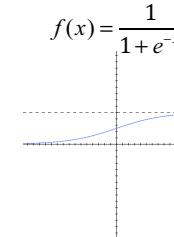
Symmetry: y-axis (even function)

Bounded below

Extrema: minimum at  $(0,0)$

H.A.: None V.A.: None

End behavior:  $\lim_{x \rightarrow -\infty} f(x) = \infty$


**Logistic Function**

Domain:  $(-\infty, \infty)$  Range:  $(0, 1)$

Continuous

Increasing:  $(-\infty, \infty)$  Decreasing: None

Symmetry: None

Bounded above and below

Extrema:

H.A.:  $y = 0$  and  $y = 1$  V.A.: None

End behavior:  $\lim_{x \rightarrow -\infty} f(x) = 0$   $\lim_{x \rightarrow \infty} f(x) = 1$