Section 3.6 One-to-one Functions; Inverse Functions

Review of Sketching the Graphs of the Basic Functions and Sketching the Graphs of Basic Functions with Restricted Domains
See Section 3.3.

Review of Graphing Piecewise-Defined Functions
LSU Video "Graphing Piecewise-Defined Functions; Shifting/Reflecting Graphs of Functions" (0:00 – 9:48) *is found on the course website.*

Recall from section 3.3 that a **piecewise-defined function** is a function defined by different rules on different parts of its domain.

Review of Using Vertical or Horizontal Shifts to Graph Functions
LSU Video "Graphing Piecewise-Defined Functions; Shifting/Reflecting Graphs of Functions" (**14:32 – 31:22)** *is found on the course website.*

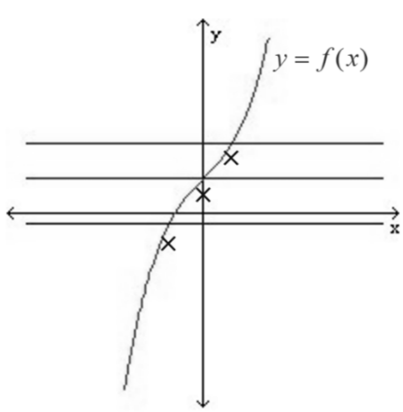
Recall from section 3.4 that for a positive number c:
The graph of $y = f(x) + c$ is obtained by shifting the graph of $y = f(x)$ upward *c* units.
The graph of $y = f(x) - c$ is obtained by shifting the graph of $y = f(x)$ downward *c* units.
The graph of $y = f(x + c)$ is obtained by shifting the graph of $y = f(x)$ to the left *c* units.
The graph of $y = f(x - c)$ is obtained by shifting the graph of $y = f(x)$ to the right *c* units.

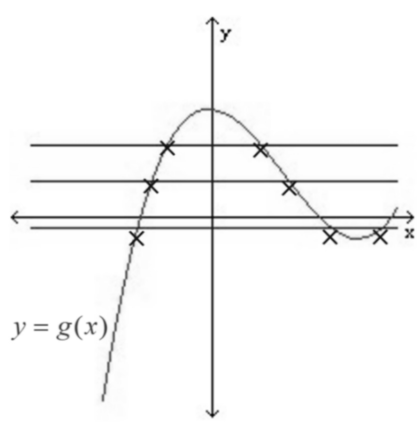
Objective 1: Understanding the Definition of a One-to-one Function

Definition: A function *f* is **one-to-one** if for any values $a \neq b$ in the domain of *f*, $f(a) \neq f(b)$.

Interpretation: For $f(x) = y$ to be a function, we know that for each x in the domain there exists one and only one y in the range. For $f(x) = y$ to be a one-to-one function, both of the following must be true: for each x in the domain there exists one and only one y in the range, AND for each y in the range there exists one and only one x in the domain.

Objective 2: Determining if a Function is One-to-one Using the Horizontal Line Test



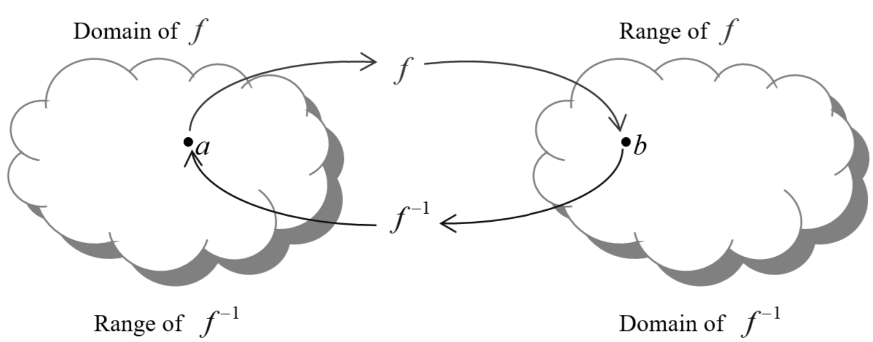


The Horizontal Line Test
If every horizontal line intersects the graph of a function *f* at most once, then *f* is one-to-one.

Objective 3: Understanding and Verifying Inverse Functions

Every one-to-one function has an inverse function.

Definition: Let *f* be a one-to-one function with domain *A* and range *B*. Then f^{-1} is **the inverse function of *f*** with domain *B* and range *A*. Furthermore, if $f(a) = b$ then $f^{-1}(b) = a$.



CAUTION Do not confuse f^{-1} with $\dfrac{1}{f(x)}$. The negative 1 in f^{-1} is NOT an exponent!

Inverse functions "undo" each other.

Composition Cancellation Equations:

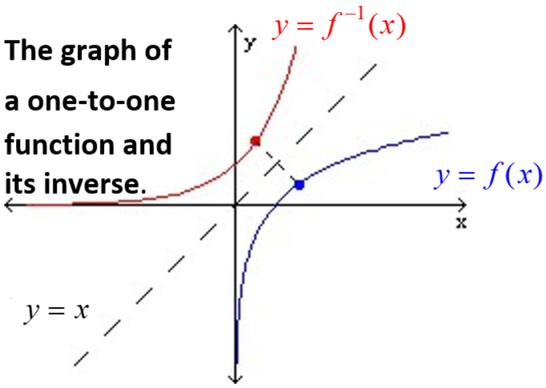
$f\left(f^{-1}(x)\right) = x$ for all x in the domain of f^{-1}

$f^{-1}\left(f(x)\right) = x$ for all x in the domain of *f*

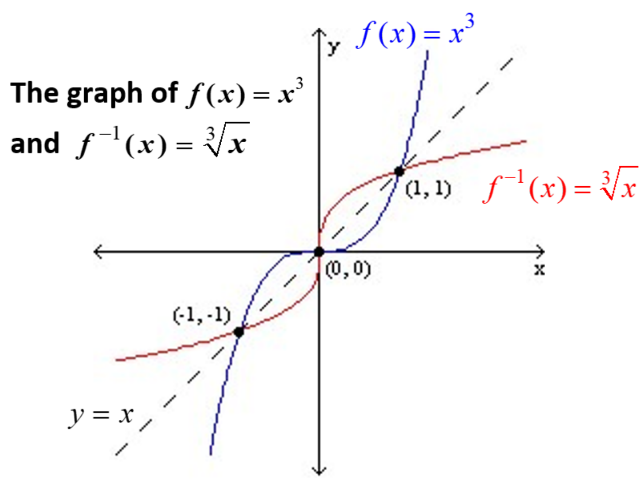
Review of Finding Function Values from a Graph
See Section 3.2.

Objective 4: Sketching the Graphs of Inverse Functions

The graph of f^{-1} is a reflection of the graph of *f* about the line $y = x$.
If the functions have any points in common, they must lie along the line $y = x$.



The graph of a one-to-one function and its inverse.



The graph of $f(x) = x^3$ and $f^{-1}(x) = \sqrt[3]{x}$

Review of Rearranging an Equation to Solve for y
See Sections 2.3 and 2.4 for linear equations. For polynomial and root equations, other equation solving techniques from Chapter 1 will be required.

Objective 5: Finding the Inverse of a One-to-one Function

We know that if a point (x, y) is on the graph of a one-to-one function, then the point (y, x) is on the graph of its inverse function.

To find the inverse of a one-to-one function, replace $f(x)$ with y, interchange the variables x and y, and then solve for y. This is the function $f^{-1}(x)$.

Inverse Function Summary

1. The inverse function f^{-1} exists if and only if the function *f* is one-to-one.
2. The domain of *f* is the same as the range of f^{-1} and the range of *f* is the same as the domain of f^{-1}.
3. To verify that two one-to-one functions *f* and *g* are inverses of each other, use the composition cancellation equations to show that $f\left(g(x)\right) = g\left(f(x)\right) = x$.
4. The graph of f^{-1} is a reflection of the graph of *f* about the line $y = x$. That is, for any point $\left(a,b\right)$ that lies on the graph of *f,* the point $\left(b,a\right)$ must lie on the graph of f^{-1}.
5. To find the inverse of a one-to-one function, replace $f(x)$ with *y,* interchange the variables *x* and *y*, and then solve for *y.* This is the function $f^{-1}(x)$.