# Function Transformations
## Read-ahead

### Introduction

The ability to understand and work with the various function transformations is important for graphing, for modeling, and also for understand properties of certain types of functions. In this application we will use the Function Transformations simulation to explore the four basic ways to transform the graph of a function: vertical shift, vertical stretch, horizontal shift, and horizontal stretch.[1]

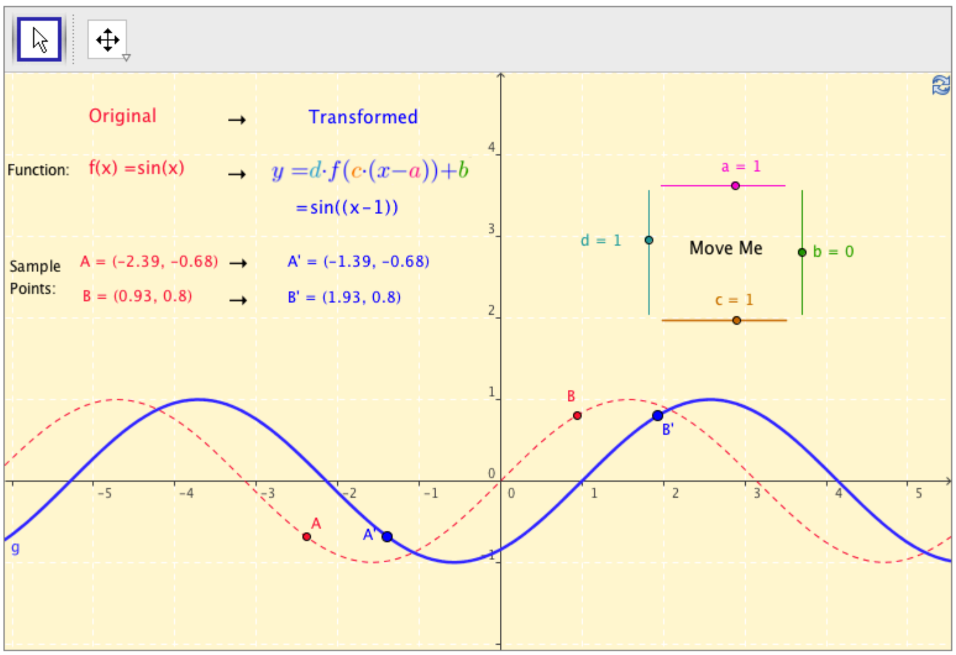


Figure 1: Screen shot of simulation

### Instructions

After reading through the *Function Transformations* context and questions below, you should complete the application reflection in Canvas. Note: *you will have a chance to talk further with your coach before answering the questions below in detail*. The point of the read-ahead is to "prime the pump" for further conversations with your coaches.

### Function Transformations

The question below all refer to the *Function Transformations* simulation linked from the "Apply" section of the module. Note that this simulation uses the notation $y = df(c(x-a)) + b$, instead of the notation $y = Af(B(x-h)) + k$ used in the textbook and in the video *Horizontal Stretching, Compression, and Flipping*.

[1]Recall that reflections can be obtained by choosing a vertical or horizontal scaling factor of $-1$.

## Questions

1. (Graded for completeness only.) We will first consider the function $y = x^4$. Enter this function in the box below the applet, and click "set function". Note that the default values are $a = c = d = 1$ and $b = 0$, so that you should be looking at the graph of $y = (x - 1)^4$ in solid blue, with the original function $f(x) = x^4$ in dotted red.

   Use the slider bar for $a$ to explore the effect of changing this value. Next, return to the value $a = 1$, and use the slider bar for $b$ to explore the effect of changing this value. Finally, set $b = 0$, and use the slider bars for $c$ and $d$ to explore the effect of changing these values.

   Suppose your friend, after playing around with the simulation, states that (at least when $a = b = 0$ and $c$ and $d$ are positive) changing $c$ has the same effect on the graph of $f(x) = x^4$ as does changing $d$. Do you agree? If so, can you use algebra to explain what is going on? If you do not agree, why not?

2. (Graded for completeness only.) Next consider the function $f(x) = 2^x$. Hit the refresh button (top right corner of the applet) so that the parameters return to their default values $a = c = d = 1$ and $b = 0$. Experiment with each slider bar to see if the graph changes in the way you expect.

   For the function $f(x) = 2^x$, there are again two parameters that (when positive) seem to have the same general effect on the graph. Which two are they? Can you use properties of the function $f(x) = 2^x$ to explain this observation?

3. Next consider the function $f(x) = \sin(2x)$. Starting with the default values $a = c = d = 1$ and $b = 0$, for what approximate positive value of $a$ is the graph of the transformed function identical to the original?

4. (Graded for completeness only.) What property of $f(x) = \sin(2x)$ implies that it is possible to shift the graph horizontally to obtain a graph that is identical to the original? Is this possible with any of the other basic transformations?

5. (Graded for completeness only.) Again, consider the function $f(x) = \sin(2x)$. Move sample point A so that it is at (approximately) the top of the first hump to the left of the $y$-axis. Move sample point B that it is at (approximately) the smallest positive root of $f(x)$. Your graphs should look like the screen shot below.

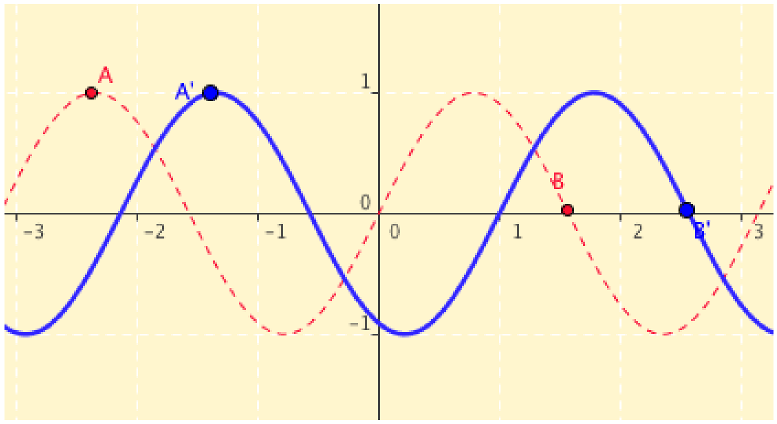


Figure 2: Positions of points A and B for Question 5

Modify the parameters $a, b, c$, and $d$ so that the transformed point A' lies (approximately) on top of the point B. Write down your values of $a, b, c$, and $d$. Can you find more than one way to do this?

**Instructions, part deux**

After reading and reflecting on these questions, complete the application reflection on Canvas. This will give your coach some insight on your thinking in order to best help you before you are required to formally answer these questions.