NEXT SLIDE

Free Calculus: Creating a Mathematics Course with Free Software

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http://srandby.org/ictcm.html

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What is Free Software?

Four Basic Principles

- Freedom to run the software
- Freedom to study and change the software
  — Requires access to the source code
- Freedom to distribute the software
- Freedom to distribute modified versions of the software

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- Free software is software that values the **liberty** of users.
- Free software may be sold.
- *Open source* software is not always free software.
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Why Use Free Software?

- It is essential to prevent lock-in and data loss.
- Maintaining control of course materials is vital.
- Proprietary software is usually tied to one or two platforms, free software is not.
- Free software is universally accessible.
- It is free!

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- The first thing one needs is a good text editor.
- Text files have many advantages over other types of files.
  - Text files are 100% portable.
  - One text file may be used as input for many different programs.
  - It is easy to use version control with text files.
- My editor of choice: Emacs
  - Emacs is almost a complete operating system.
  - I use Org-Mode, an Emacs "mode" for notes, planning, record keeping, developing web pages, and much more.
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- A good way to get started is to go to http://tug.org/begin.html.
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Sample Materials

- Each lecture is a single PDF file.
- The top of each slide provides navigation information.

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Defintion 1

A line is *tangent* to a circle if the line and circle have exactly one point in common.

The diagram given below illustrates the definition.

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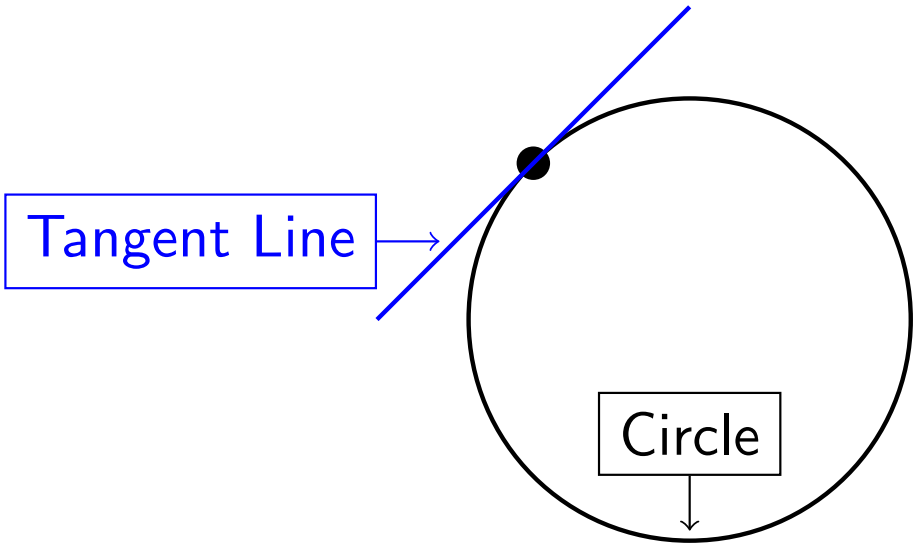

Below is the code for the graphic on the previous slide.

```
\begin{tikzpicture}[scale=1]
 \draw[thick] (0,0) circle (1.41421);
 \draw[<-] (0,-1.35)--(0,-1)
  node[above,rectangle,draw,fill=white] {Circle};
 \draw[fill=black] (-1,1) circle (0.10);
 \draw[color=blue,thick] (-2,0)--(0,2);
 \draw[<-,color=blue] (-1.6,0.5)--(-2,0.5)
  node[left,rectangle,draw,fill=white] {Tangent Line};
\end{tikzpicture}
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Using TikZ, animations are possible as the next slide shows.

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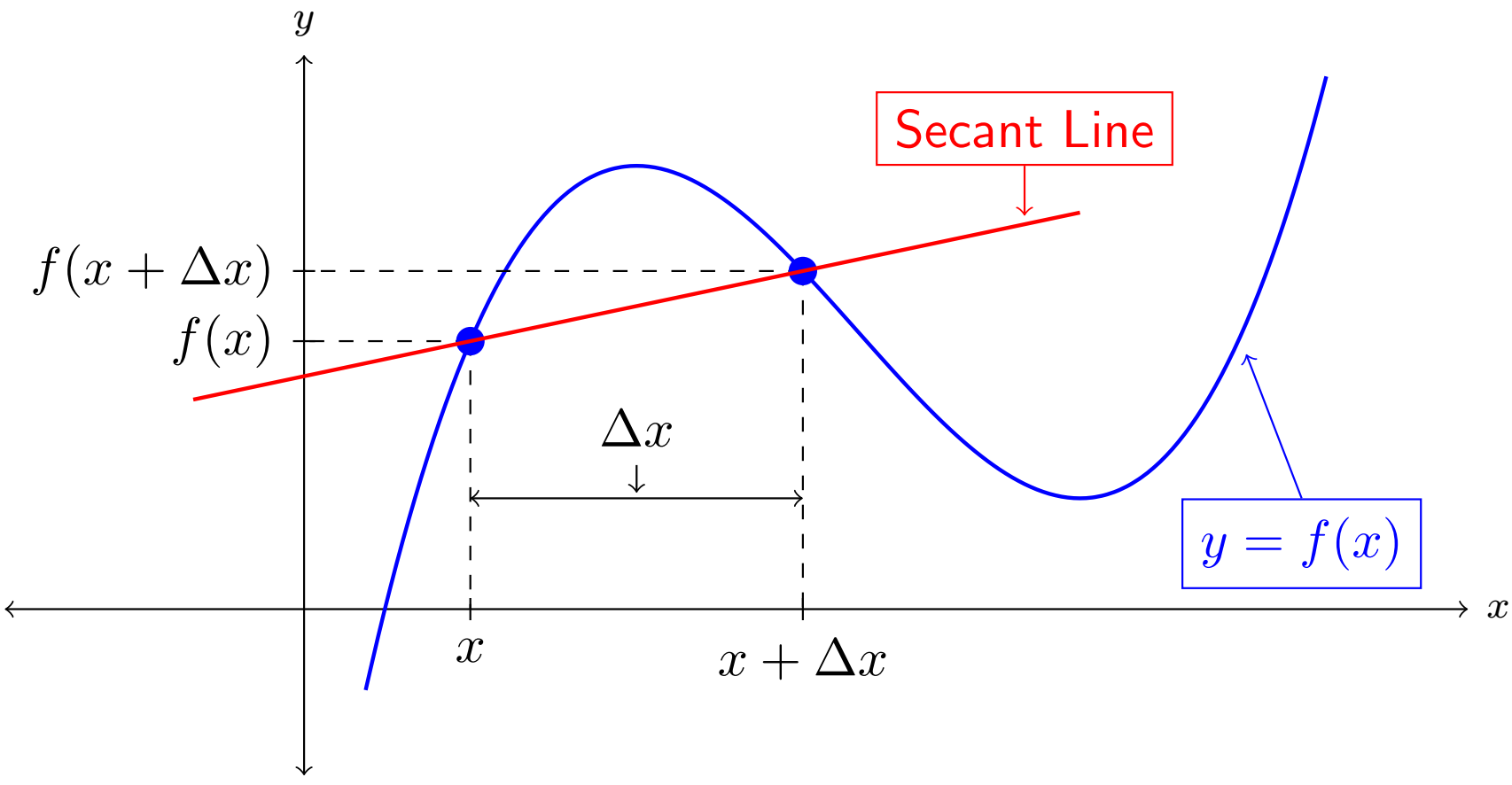
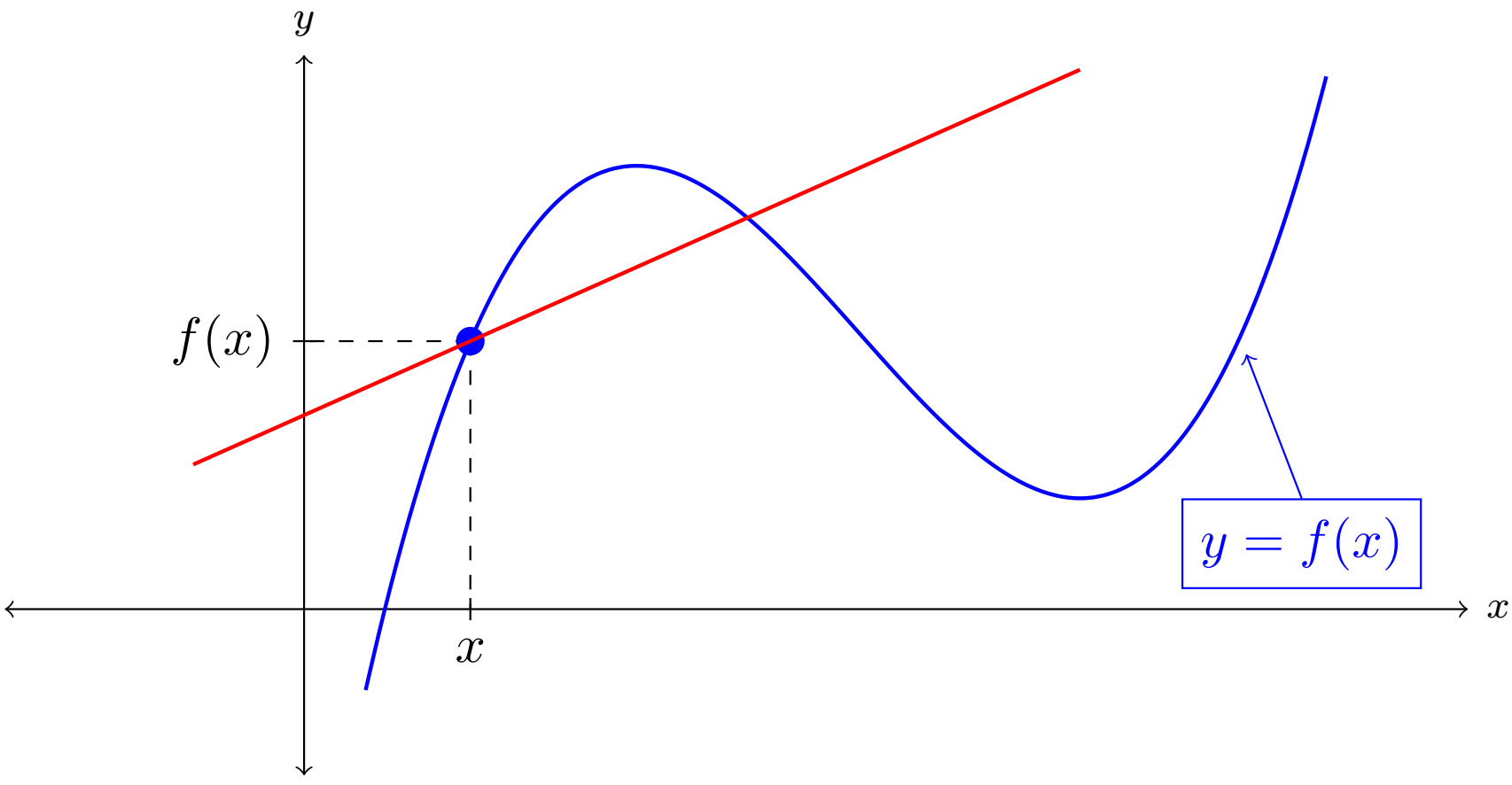


Letting Δx approach 0 is taking a limit. So, a tangent line is found by using the limit concept.



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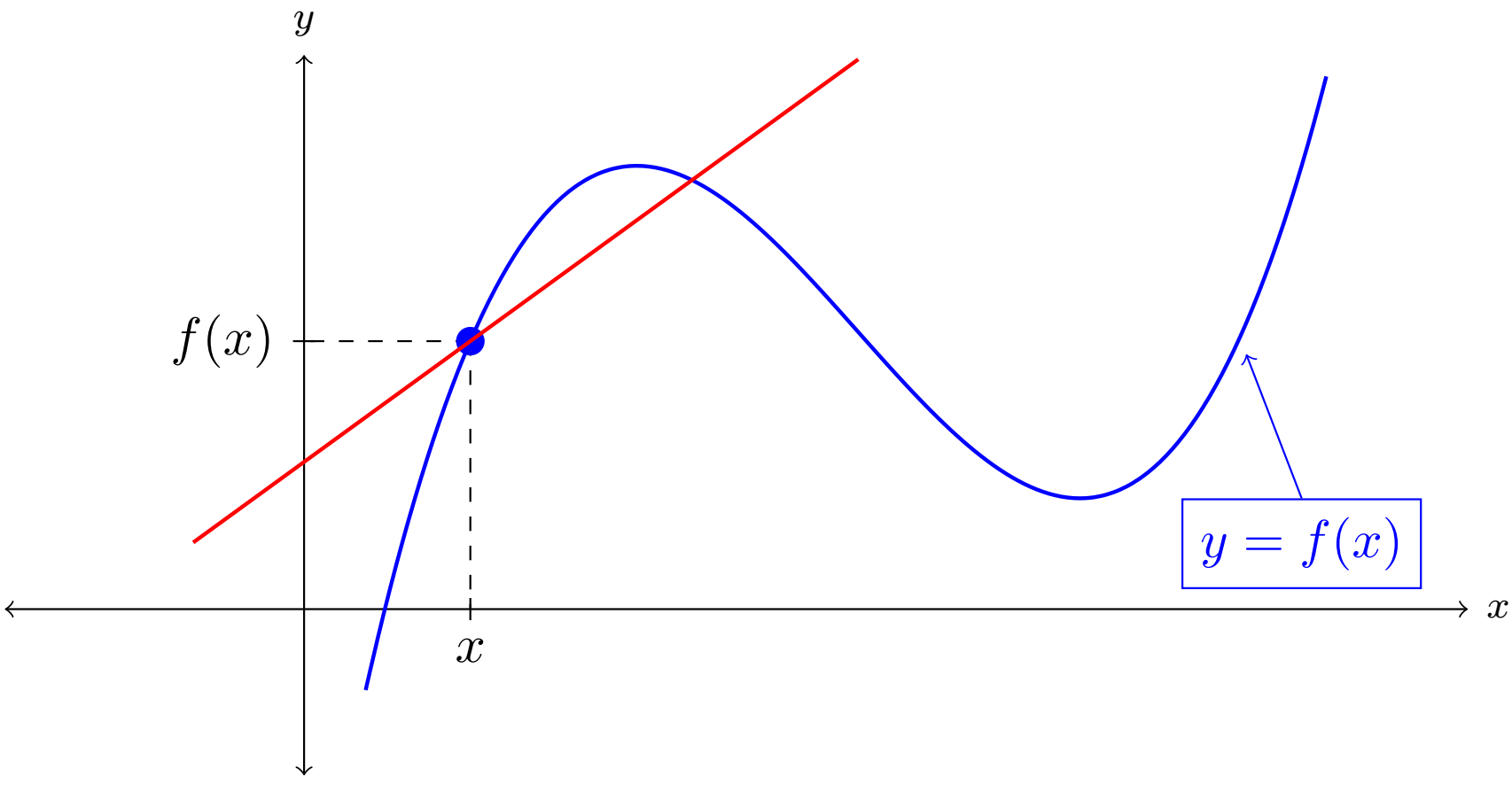

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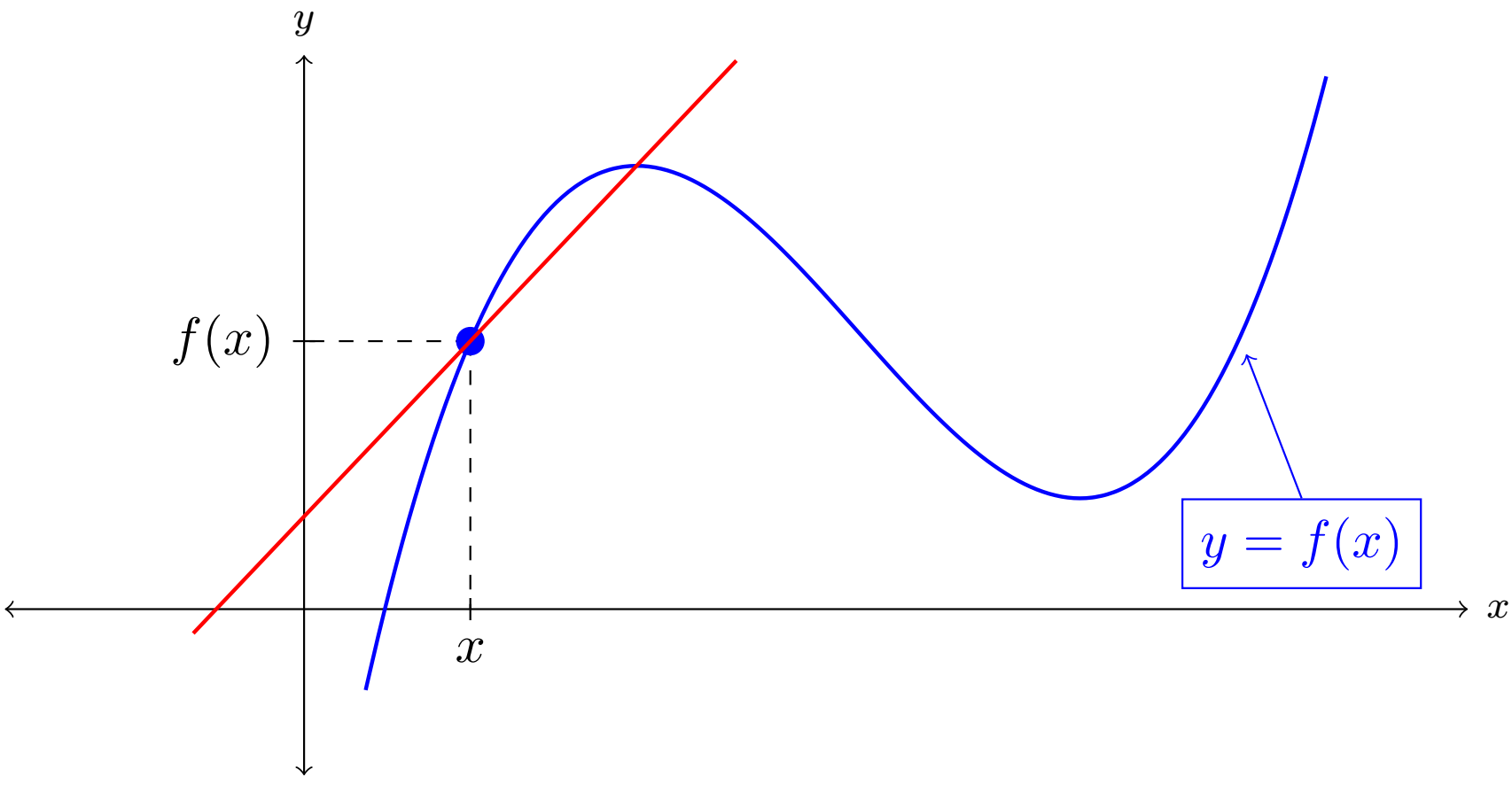

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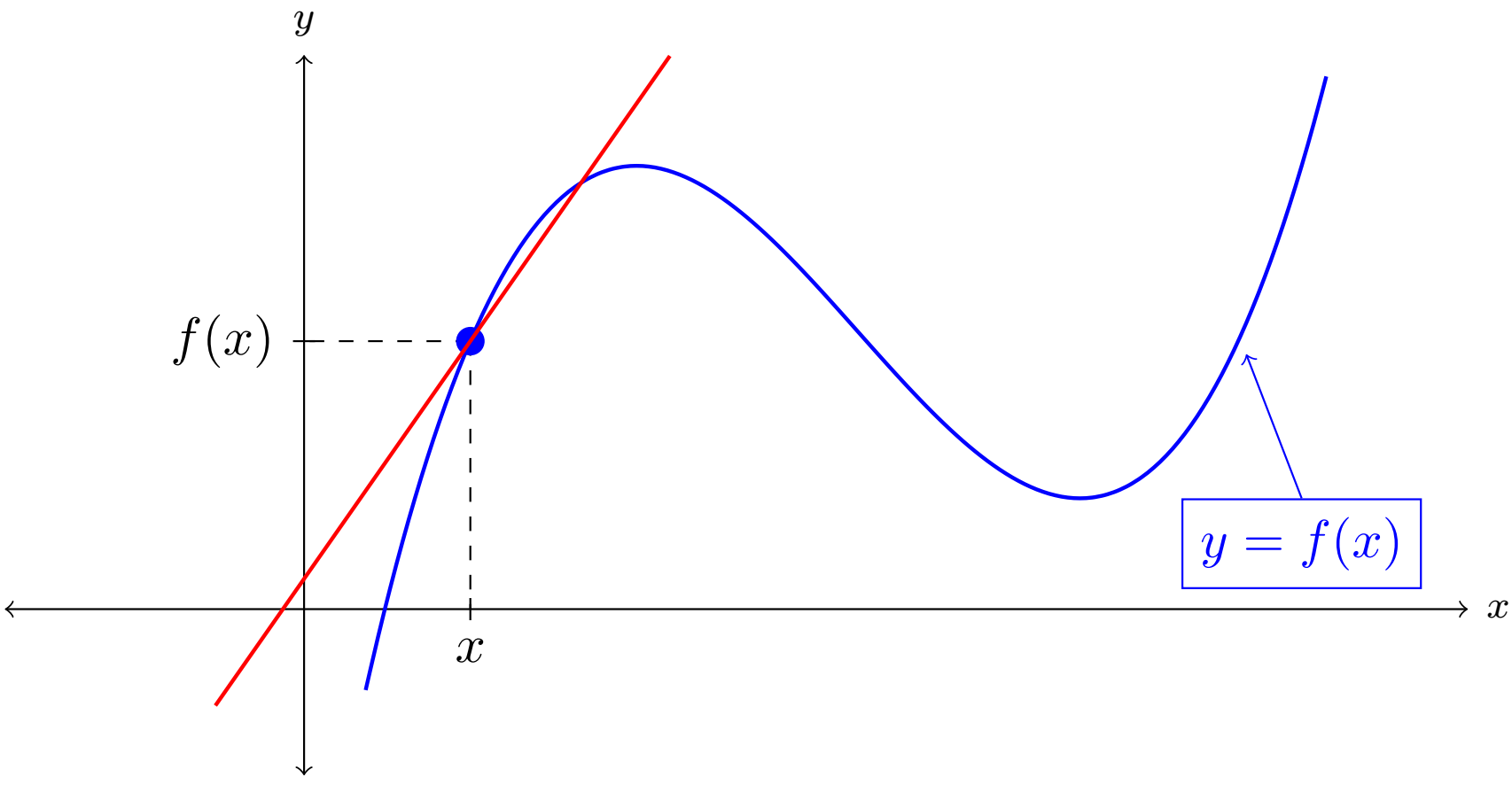

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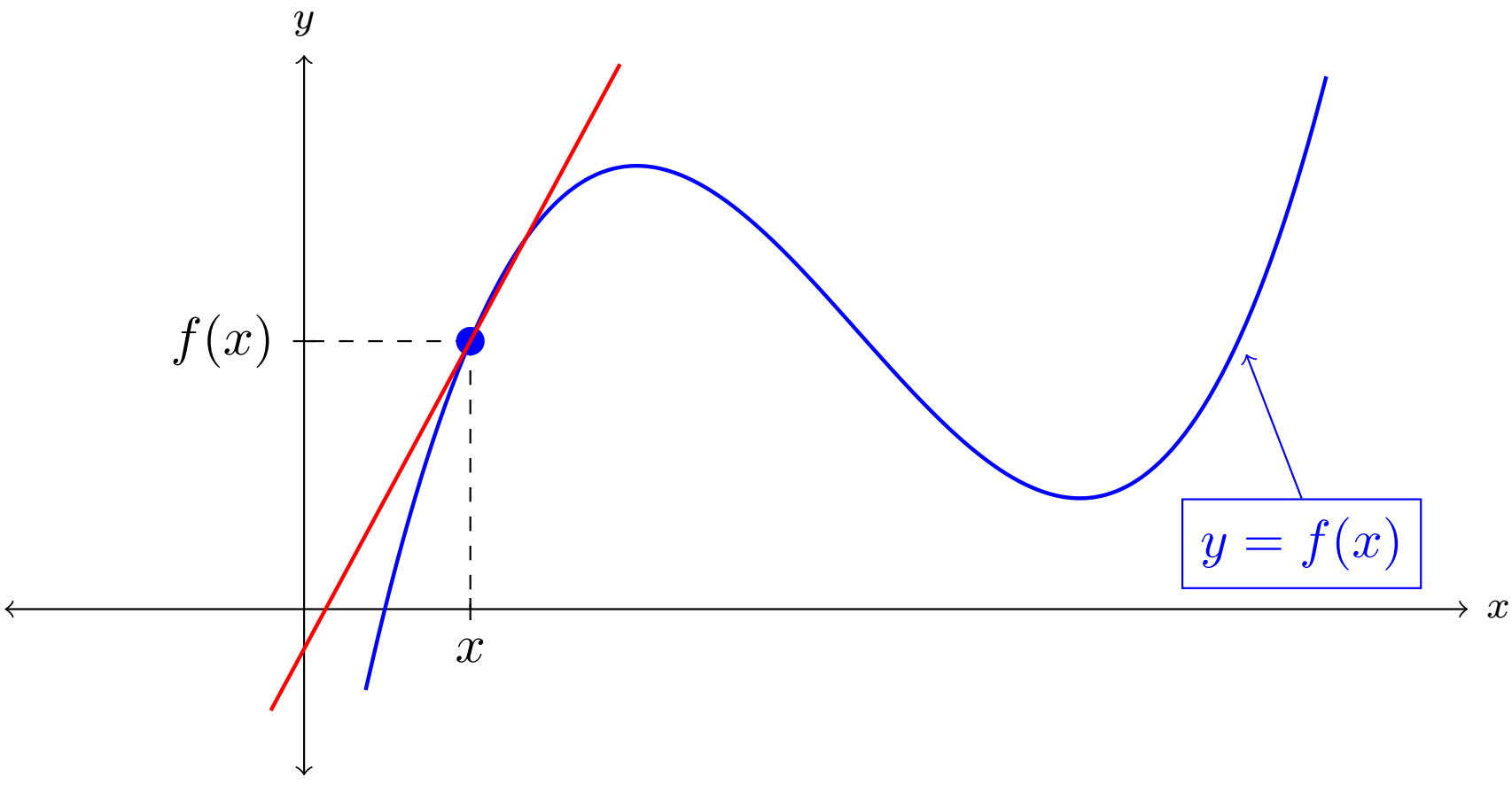

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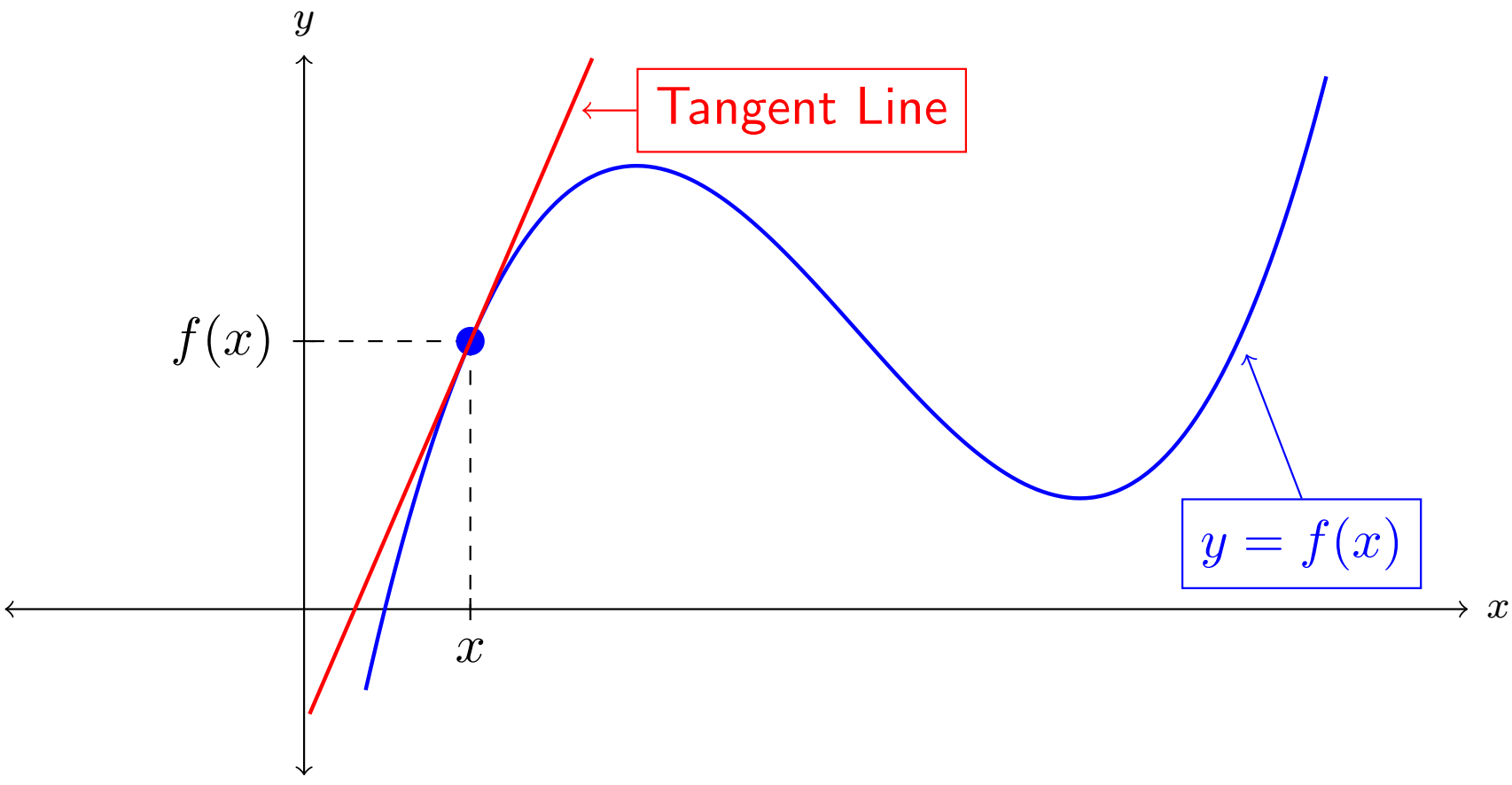

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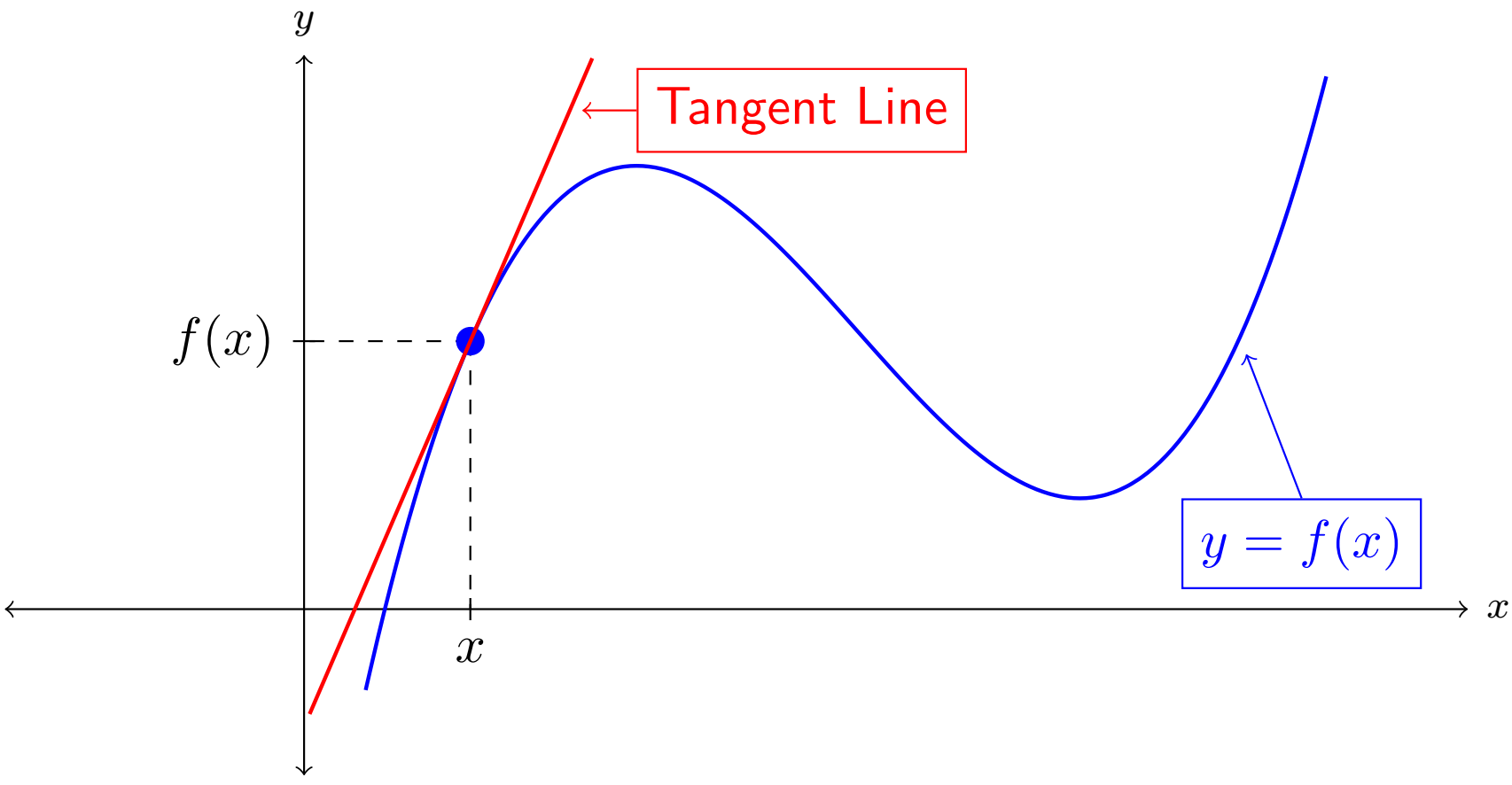

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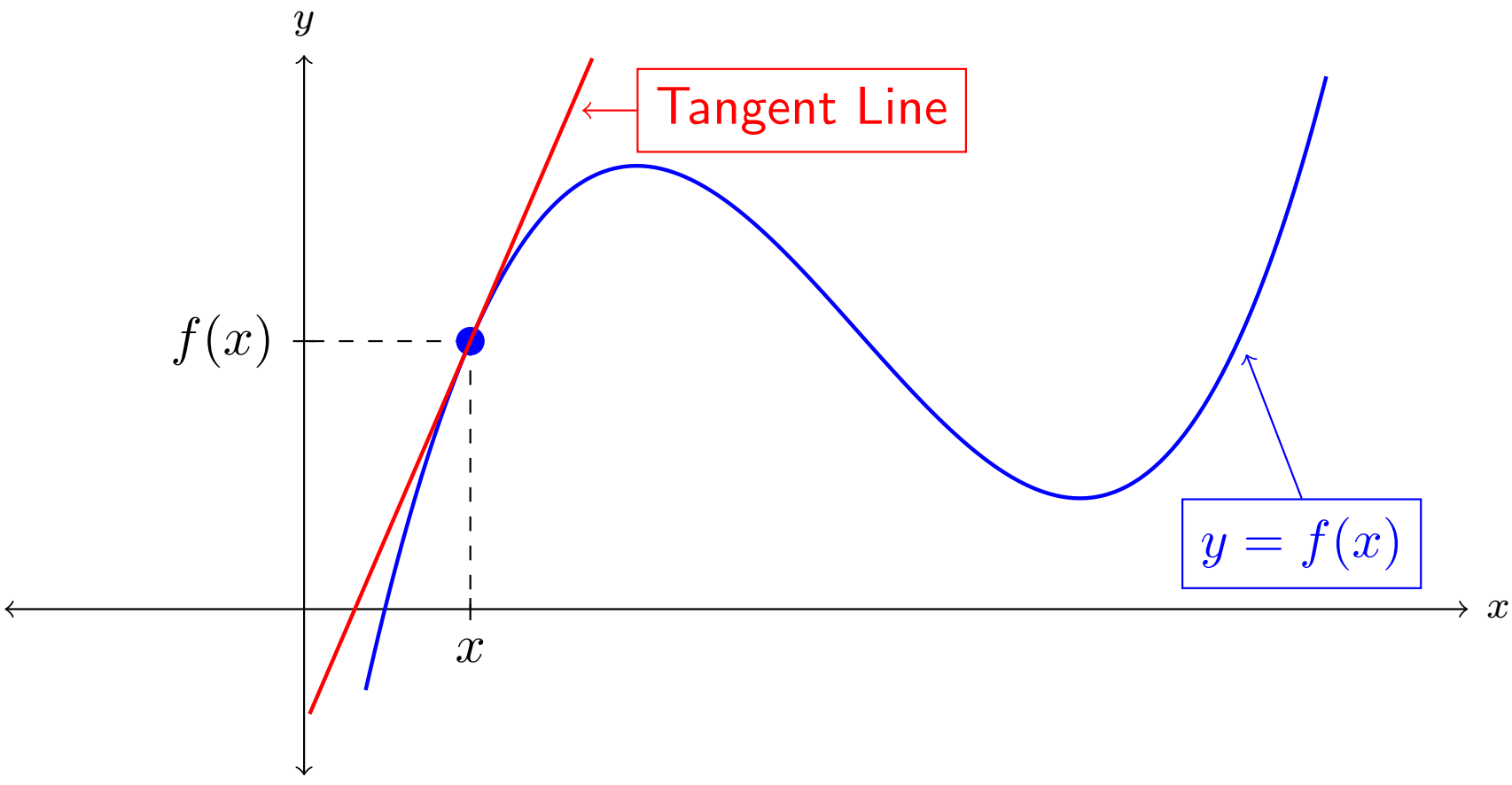

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The blue curve in the animation is inserted with the following code.

```
\draw[thick,color=blue] plot[smooth] file {Graph.table};
```

The file "Graph.table" is simply a list of points on the curve that Gnuplot generated. The beginning of this file is shown below.

```
#Curve 0 of 1, 100 points
#x y type
 0.555556 -0.730453  i
 0.666667 -0.253472  i
 0.777778  0.193416  i
 0.888889  0.610983  i
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 1.11111  1.36124  i
 1.22222  1.69547  i
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unset table
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Students may go through examples step by step.

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Example 1

A. Find the slope of the tangent line of the curve $y = 4 - x^2$ at the point $(3, -5)$.

We are given that $y = f(x) = 4 - x^2$ and $x = 3$ so,

$$\begin{aligned} m_{tan} &= \lim_{\Delta x \to 0} \frac{f(x + \Delta x) - f(x)}{\Delta x} = \lim_{\Delta x \to 0} \frac{f(3 + \Delta x) - f(3)}{\Delta x} \\ &= \lim_{\Delta x \to 0} \frac{4 - (3 + \Delta x)^2 - \left(4 - 3^2\right)}{\Delta x} \\ &= \lim_{\Delta x \to 0} \frac{4 - \left(9 + 6\Delta x + \Delta x^2\right) - (-5)}{\Delta x} \\ &= \lim_{\Delta x \to 0} \frac{4 - 9 - 6\Delta x - \Delta x^2 + 5}{\Delta x} \end{aligned}$$

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We are given that $y = f(x) = 4 - x^2$ and $x = 3$ so,

$$m_{tan} = \lim_{\Delta x \to 0} \frac{f(x + \Delta x) - f(x)}{\Delta x} = \lim_{\Delta x \to 0} \frac{f(3 + \Delta x) - f(3)}{\Delta x}$$

$$= \lim_{\Delta x \to 0} \frac{4 - (3 + \Delta x)^2 - \left(4 - 3^2\right)}{\Delta x}$$

$$= \lim_{\Delta x \to 0} \frac{4 - \left(9 + 6\Delta x + \Delta x^2\right) - (-5)}{\Delta x}$$

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$$m_{tan} = \lim_{\Delta x \to 0} \frac{-6\Delta x - \Delta x^2}{\Delta x} = \lim_{\Delta x \to 0} \frac{\Delta x(-6 - \Delta x)}{\Delta x}$$
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Problems are included.

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Solution: $m_{tan} = -8$

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Results

- Finished only half of the lectures before the course began.
- Students preferred on-line lectures over traditional lectures.
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