There will be three parts in Exam 1: one of Definitions, one for multiple choice problems, and a section of work out problems. It will cover Sections 1.1-1.3, 1.5, 1.6, 2.1-2.5. Here are the concepts you are expected to know:

Definitions You Should Know:

(a) A function \( f \) is increasing on an interval \([a, b]\) if \( f(x_1) < f(x_2) \) whenever \( x_1 < x_2 \).

(b) A function \( f \) is decreasing on an interval \([a, b]\) if \( f(x_1) > f(x_2) \) whenever \( x_1 < x_2 \).

(c) A function \( f \) is even if \( f(-x) = f(x) \) for all \( x \).

(d) A function \( f \) is odd if \( f(-x) = -f(x) \) for all \( x \).

(e) A function \( f \) is one-to-one if \( f(x_1) \neq f(x_2) \) whenever \( x_1 \neq x_2 \).

(f) A function \( f \) is left continuous at \( a \) if \( \lim_{x \to a^-} f(x) = f(a) \).

(g) A function \( f \) is right continuous at \( a \) if \( \lim_{x \to a^+} f(x) = f(a) \).

(h) A function \( f \) is continuous at \( a \) if \( \lim_{x \to a} f(x) = f(a) \).

(i) If \( \lim_{x \to a^-} f(x) = \lim_{x \to a^+} f(x) = L \), then we define the (two-sided) limit to be \( \lim_{x \to a} f(x) = L \).

(j) \( \lim_{x \to \infty} f(x) = \infty \) means that as \( x \) grows larger, \( f(x) \) grows larger without bound.

(k) \( \lim_{x \to \infty} f(x) = -\infty \) means that as \( x \) grows larger, \( f(x) \) grows larger without bound.

Other Topics:

- Know the different types of function classes that we talked about in Section 1.2.
- Know all of the different operations (shifting, stretching, reflecting) from Section 1.3 for getting new functions from old ones.
- Know how to work with the absolute value function, including its definition.
- Know how to do Exponential growth/decay problems! There will definitely be a problem like this on the exam.
- Know how to find the graph of an inverse function (i.e. reflecting it about the \( y = x \) line)
- Know how to algebraically solve for the inverse of a one-to-one function.
- Know properties of logarithms and exponential functions, and how they relate to one another (including cancellation equations).
• Know how to find the average velocity and estimate instantaneous velocity.

• Think about our example finding average velocity from Section 2.1.

• Know Point-Slope Form equation for finding the equation of a line between two given points.

• Know how to determine left and right-sided limits and two-sided limits from the graph of a function.

• Know how to determine where a function is increasing, decreasing, and continuous from its graph.

• Know what the graphs of even and odd functions look like.

• Know the Limit Laws from Section 2.3 and how to apply them to compute limits algebraically.

• Know how to find the Domain and Range for all of the kinds of functions we have discussed, and use these to determine where a function is continuous.

• Know how to take limits of functions to $-\infty$ and $\infty$.

• Know how to determine if the one-sided limit of a function is $-\infty$ or $\infty$ at a vertical asymptote.

• Know how to find Horizontal and Vertical asymptotes of functions.

Example Problems:

1. Starting with the graph of $y = e^x$, write the equation of the graph that results from the following changes.

   (a) shifting 3 units downward

   (b) shifting 7 units to the right

   (c) reflecting about the x-axis

   (d) reflecting about the x-axis then about the y-axis
2. Under ideal conditions a certain bacteria population is known to double every four hours. Suppose there are initially 40 bacteria.

(a) What is the size of the population after 8 hours?

(b) What is the size of the population after t hours?

(c) When the population reaches 640?

3. Find \( \lim_{x \to -4} \frac{\sqrt{x^2 + 9} - 5}{x + 4} \).
4. Find the values $a$ and $b$ that make $f$ continuous everywhere.

$$f(x) = \begin{cases} 
\frac{x^2 - 4}{x - 2} & \text{if } x < 2 \\
ax^2 - bx + 3 & \text{if } 2 < x < 3 \\
2x - a + b & \text{if } x \geq 3 
\end{cases}$$

5. Locate the discontinuities of the function $f(x) = \frac{2}{8 + e^{1/x}}$. 
6. If $f$ and $g$ are continuous functions with $f(-3) = 4$ and the following limit, find $g(-3)$. 

$$\lim_{x \to -3} (5f(x) - g(x)) = 14$$

7. Find the horizontal and vertical asymptotes of the curve.

$$y = \frac{x^2 - 9}{x^2 + 4x - 21}$$
8. Evaluate \( \lim_{x \to \infty} \sqrt{9x^2 + 1} - 3x \).

9. Find the inverse function of \( f(x) = \sqrt{2 - e^{2x}} \), and state its domain.

10. Find \( \lim_{x \to 2} \frac{1 - x}{x^2 - 4} \).