Prof. Lacoste  

Exam 4 (Schedule)
- Class in noon
  Exam 4 time: 1:00 pm - 3:30 pm
- Class at 3:00
  Exam 4 time: 5:00 pm - 7:30 pm
  December 9

4.3 Logarithmic Functions

* Logarithm is a missing exponent
EGOB = Exponent that Goes On Base
Examples p. 196

- Evaluate Logarithmic Expressions

\[ \log_b \left( \frac{a}{b} \right) = \log_b a - \log_b b = \log_b \frac{a}{b} \]

"log base to... of..."
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4.3 Logarithmic Functions

*Logarithm is a missing exponent*

EGOB $\rightarrow$ Exponent that Goes On Base

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*Evaluate Logarithmic Expressions

$$\log_{\text{square}}(\text{rectangle}) = \text{square} \leftrightarrow \text{rectangle} - 0$$

"log base to... of..."
\( \log_6 6 = 1 \quad \text{(a)} \quad \log_q 1 = 0 \quad \text{(c)} \)

\( \log_{64} \frac{64}{64} = -3 \quad \text{(b)} \quad \log_4 64 = 2 \quad \text{(c)} \)

\( 6^1 = \frac{1}{64} \)

\( 4^2 = 1 \)

\( 4^2 = \frac{1}{4^{-2}} \)

\( 4^2 = 4^{-2} \)

\( ? = -3 \)

• Converting Between Logarithmic and Exponential Forms

Exponential Form: \( a = x \leftrightarrow y = \log_a x \)

Logarithmic Form: \( \text{base} \)

Exponential Form: \( \text{exponent} \)

\( \log_6 \frac{1}{6} = -1 \quad \text{(a)} \quad \log_2 \frac{1}{32} = -5 \leftrightarrow 2^{-5} = \frac{1}{32} \quad \text{(c)} \)
(b) $7^2 = 49$
\[ \log_7 49 = 2 \]
\[ 4^3 = 64 \]

- The "Common" Log & the "Natural" Log

The two most frequently seen log bases are 10 & e. Because of this, each gets a special name. $\log_{10} x$ is called the common log, $\log_e x$ is called the natural log & gets its own notation: $\ln x$. Both the common log (log) and the natural log (ln) have buttons on your calculator. When log is written without a base, you must research what the base is. In your book/homework/calculator, $\log x$ means $\log_{10} x$. But older math books, $\log x$ means $\log_e x = \ln x$. Be Careful!

*ALEKS Problems

(a) $\ln x = 3$
\[ \log_e x = 3 \]
\[ e^3 = x \]

(b) $e^y = 9$
\[ \log_e 9 = y \]
\[ \ln 9 = y \]

(a) $e^y = x$
\[ \ln x = 8 \]

(b) $\ln 4 = y$
\[ e^y = 4 \]
\[ f(x) = b^x \] Let's find the inverse

Replace \( f(x) \) with \( y \)

\[ y = b^x \]

Swap \( x \)'s and \( y \)'s

\[ x = b^y \]

Solve for \( y \) using the converter

\[ y = \log_b x \]

Replace \( y \) with \( f^{-1}(x) \)

\[ f^{-1}(x) = \log_b x \]

*Exponential function \& logarithmic function are inverse of each other*

• Graph Logarithmic Functions

- The exponential function approach the horizontal asymptote \( y = 0 \), whereas the logarithmic function approach the vertical asymptote \( x = 0 \).

- When you are choosing \( x \) that are integer powers of the base.
(2) \( x \) \hline \( y = \log_{\frac{1}{3}} x \)  
\( (\frac{1}{3})^{-2} = 9 \) \( y = \log_{\frac{1}{3}} 9 = -2 \) \( (9, -2) \)  
\( (\frac{1}{3})^{-1} = 3 \) \( y = \log_{\frac{1}{3}} 3 = -1 \) \( (3, -1) \)  
\( (\frac{1}{3})^0 = 1 \) \( y = \log_{\frac{1}{3}} 1 = 0 \) \( (1, 0) \)  
\( (\frac{1}{3})^{\frac{1}{3}} = \frac{1}{3} \) \( y = \log_{\frac{1}{3}} \frac{1}{3} = 1 \) \( (\frac{1}{3}, 1) \)  
\( (\frac{1}{3})^{\frac{1}{3}} = \frac{1}{9} \) \( y = \log_{\frac{1}{3}} \frac{1}{9} = 2 \) \( (\frac{1}{9}, 2) \)  

(3) \( x \) \hline \( y = \log_3 x \)  
\( (3)^{-2} = \frac{1}{9} \) \( y = \log_3 \frac{1}{9} = -2 \) \( (\frac{1}{3}, -2) \)  
\( (3)^{-1} = \frac{1}{3} \) \( y = \log_3 \frac{1}{3} = -1 \) \( (\frac{1}{3}, -1) \)  
\( (3)^0 = 1 \) \( y = \log_3 1 = 0 \) \( (1, 0) \)  
\( (3)^1 = 3 \) \( y = \log_3 3 = 1 \) \( (3, 1) \)  
\( (3)^2 = 9 \) \( y = \log_3 9 = 2 \) \( (9, 2) \)