Directed Study in Mathematics | Name ______________________

2.2 Hyperbolic Functions | Date ______________ Pd ______

Required reading:

- Larson 9e: pages 390-397
- Dawkins: Calculus I, section 3-8: Derivatives of Hyperbolic Functions
  http://tutorial.math.lamar.edu/Classes/CalcI/DiffHyperFcns.aspx
  - Notes: Read all. (Last modified: 05/30/2018)
  - Practice Problems: Review all. (Last modified: 02/07/2018)

Required homework:

- Larson 9e: pages 398-399, problems 52, 55, 60, 68, 72, 73, 88, 93, 97
- Dawkins: Assignments problems 1, 4, 6 (Last modified: 02/07/2018)

Additional comments regarding this topic:

Hyperbolic functions are an interesting class of functions—based on exponentials, yet sharing similar properties to trigonometric functions. When studying hyperbolic functions, it is useful to take advantages of those similarities, but we have to remember the differences.

For example, the double-angle identity for $\sinh(2x)$ is similar to the double-angle identity for $\sin(2x)$:

$$\sinh(2x) = 2\sinh(x)\cosh(x)$$
$$\sin(2x) = 2\sin(x)\cos(x)$$

But the double-angle identity for $\cosh(2x)$ is slightly different from the double-angle identity for $\cos(2x)$. (In fact, the double-angle identity for $\cosh(2x)$ closely resembles a trigonometric Pythagorean identity, which closely resembles a hyperbolic Pythagorean identity!)

$$\cosh(2x) = \cosh^2(x) + \sinh^2(x) \qquad \cosh^2(x) - \sinh^2(x) = 1$$
$$\cos(2x) = \cos^2(x) - \sin^2(x) \qquad \cos^2(x) + \sin^2(x) = 1$$

The same is true with the calculus of hyperbolic functions. Compare the derivatives of $\sinh(x)$ and $\cosh(x)$ with their trigonometric counterparts. (With this example alone, we see the negative "rule" we saw with the derivative of the trigonometric co- functions do not apply in the same manner with the hyperbolic functions.)

$$\frac{d}{dx}\left[\sinh(u)\right] = \cosh(u)\,u' \qquad \frac{d}{dx}\left[\cosh(u)\right] = \sinh(u)\,u'$$
$$\frac{d}{dx}\left[\sin(u)\right] = \cos(u)\,u' \qquad \frac{d}{dx}\left[\cos(u)\right] = -\sin(u)\,u'$$

Additional comments regarding the Larson reading:

This reading contains an extensive introduction of hyperbolic functions—it assumes we have not seen these type of functions before. We are not too concerned with these portions of the reading, but it is still good background information to know before delving into the calculus of hyperbolic functions.