MATH 210
RULES FOR DIFFERENTATION, PART 3

Atomic Rules

$$\frac{\mathrm{d}}{\mathrm{d}x} b^x = \ln(b) \cdot b^x \qquad (b > 0 \text{ and } b \neq 1)$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \log_b(x) = \frac{1}{\ln(b)x} \qquad (b > 0 \text{ and } b \neq 1)$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \arcsin x = \frac{1}{\sqrt{1-x^2}}$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \arccos x = -\frac{1}{\sqrt{1-x^2}}$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \arctan x = \frac{1}{1+x^2}$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \operatorname{arcsec} x = \frac{1}{|x|\sqrt{x^2-1}}$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \operatorname{arccsc} x = -\frac{1}{|x|\sqrt{x^2-1}}$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \operatorname{arccot} x = -\frac{1}{1+x^2}$$

Combination Rule (Chain Rule)

$$\frac{\mathrm{d}}{\mathrm{d}x} f(u(x)) = f'(u(x)) \cdot u'(x)$$

$$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{\mathrm{d}y}{\mathrm{d}u} \cdot \frac{\mathrm{d}u}{\mathrm{d}x}$$

Differentiate the following functions:

- $a(x) = \arcsin(2x)$
- $b(x) = \arctan(x\pi)$
- $c(x) = e^{\ln(2)\cdot x}$
- $d(x) = e^{-x^2}$
- $f(x) = \log_{10}(e^x)$
- $g(x) = (2x-1)^5$
- $h(x) = x^2 e^{2x}$
- $i(x) = \cos^2 x - \cos(x^2)$
- $j(x) = \sin(\arccos x)$
- $k(x) = \arctan(\sin x)$

(1) Use the chain rule and product rule to explain why the quotient rule works.
(2) Use the chain rule and the rule for e^x to explain why the rule for b^x works.
(3) Use the rule for $\ln x$ to explain why the rule for $\log_b x$ works.