- $\frac{d}{dx}[f(x)g(x)] = f'(x)g(x) + g'(x)f(x)$
- $\frac{d}{dx}\left(\frac{f(x)}{g(x)}\right) = \frac{g(x)f'(x) - f(x)g'(x)}{[g(x)]^2}$
- $\frac{d}{dx}f(g(x)) = f'(g(x))g'(x)$ and $\frac{d}{dx}x^r = rx^{r-1}$, for all r
- $\frac{d}{dx}\sin(x) = \cos(x)$, $\frac{d}{dx}\cos(x) = -\sin(x)$
- $\frac{d}{dx}\tan(x) = \sec^2(x)$, $\frac{d}{dx}\sec(x) = \tan(x)\sec(x)$
- $\sin^2(x) + \cos^2(x) = 1$ and $\tan^2(x) + 1 = \sec^2(x)$
- $\tan(x) = \frac{\sin(x)}{\cos(x)}$, $\cot(x) = \frac{1}{\tan(x)}$, $\sec(x) = \frac{1}{\cos(x)}$, $\csc(x) = \frac{1}{\sin(x)}$

1. (8 points) Show that if a function f is differentiable at $x = c$, then it is continuous at $x = c$.

2. (8 points) Let $f(x) = -\frac{1}{3}x^3 + x^2 - x + 5$. Find the intervals on which (a) $f(x)$ is increasing or decreasing, (b) the graph of f is concave upward or concave downward, and (c) find the relative extrema and inflection points of f, indicate if the extrema an absolute extrema.

3. (8 points) Find the equation of the tangent line to the curve of $2x + xy - 2 = \ln(x^3 + y^2)$ at the point $(1, 0)$.

4. (8 points) Find the absolute maximum and absolute minimum (if any) of
$h(t) = (e^{-t} + e^t)^3 \quad$ for $-2 \le t \le 3$.

5. (40 points) Find the derivative $\frac{dy}{dx}$ or $f'(x)$ where

   (a) $y\, e^{5x - x^3} = 5\sin(4x) + y^2 \ln((2x^3 + 5)^2) + \log_5 y$ (b) $f(x) = x^x\, 6^{x^3}$

   (c) $f(x) = 5\sec^2(\ln(3\sqrt{x}))$ (d) $f(x) = \frac{(5x-1)(7x-2)(8x-3)(3x-4)}{(5x+1)(7x+2)(8x+3)(3x+4)}$

   (e) $f(x) = \tan^{-1}(x) =$ the inverse function of $\tan(x)$

6. (24 points) Find the indicated limit or show it does not exist. If the limiting value is infinite, indicate whether it is ∞ or $-\infty$.

   (a) $\lim_{x \to 0}(e^{-2x} - 3x)^{2/x}$ (b) $\lim_{x \to 0} \frac{\sin(7x)}{\sin(\sqrt{\pi}x)}$, (c) $\lim_{t \to \infty} t^5 e^{-2t}$

7. (8 points) Let for $x \neq 0$,
$$f(x) = |x|^x.$$
Describe the interval(s) on which the function $f(x)$ is continuous. If there are any discontinuities, determine whether they are removable.