$*$ **Note:** No points will be given if no arguments are provided for an answer.

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

Good Luck! ∼∼ *Yuling* ⌣̈

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

$$(a)\quad \lim_{x\to 0}(e^{-2x} + 5x)^{1/x} \qquad (b)\quad \lim_{x\to 0}\frac{\sin(9x)}{\sin(3x)}, \qquad (c)\quad \lim_{t\to\infty} t^3 e^{-6t}$$

4. (8 points) Find the equation of the tangent line to the curve of $2x + xy - 2 = \ln(x^3 + y^2)$ at the point $(1, 0)$.

5. (8 points) Find the absolute maximum and absolute minimum (if any) of
$h(t) = (e^{-t} + e^t)^3$ for $-1 \le t \le 3$.

6. (40 points) Find the derivative $\frac{dy}{dx}$ or $f'(x)$ where

(a) $e^{2x-x^5}\log_7 y = 5\sin(2x) + y^2\ \ln((3x^2+1)^2)$ (b) $f(x) = x^x\, 3^{x^2}$

(c) $f(x) = 3\tan^2(\ln(\sqrt{5x}))$ (d) $y = \frac{(2x^3e^{-2x})^6(3x^2-x+2)^5}{[1+\cos(4x^2)+x^8]^{-2.3}}$

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

7. (8 points) Find $f(x)$ by solving the initial value problem:

$$f'(x) = 1 + e^x + \frac{1}{x}, \quad f(1) = 3 + e$$