Do not omit scratch work. I need to see all steps. Skipping details will result in a loss of credit. Thanks. You are allowed the use of a scientific (non-graphing) calculator. No electronic communication devices of any kind permitted, no IPODs, Zunes, Walkmans etc... This is a timed test and time is likely to be an issue for you, budget your time wisely. There are at least 150pts to earn on this exam.

**Problem 1** [7pts] Let $f(x) = x^2 + x$. Calculate:

$(a.)\ f'(x) =$ ____________, $(b.)\ \dfrac{d}{dx}[f'(x)] =$ ____________.

**Problem 2** [63pts] Complete the indicated derivatives. If more than one variable is present in an expression you may assume that the variables are independent.

$(a.)\ \dfrac{d}{dx}\left[\dfrac{x^2+3x+7}{\sqrt{x}} + \pi^3\right]$

$(b.)\ \dfrac{d}{db}\left[ax^2 + bx + c\right]$

$(c.)\ \dfrac{d}{dx}\left[(1-3x)^6(x^2+x)^3\right]$

$(d.)\ \dfrac{d}{dx}\left[\sqrt{3-x}\right]$

$(e.)\ \dfrac{d}{dx}\left[\sqrt[3]{x+\sqrt{4x^2}}\right]$

$(f.)\ \dfrac{d}{dx}\left[\ln\left(Ae^{Bx+C}\right)\right]$

$(g.)\ \dfrac{d}{dx}\left[\sin\left[x^3+2\cos(7x)\right)\right]\right]$

$(h.)\ \dfrac{d}{dx}\left[sin^{-1}(\,3e^{x}\,)\right]$

$(i.)\ \dfrac{d}{dx}\left[\dfrac{\cot(x)}{x-e^{-2x}}\right]$

**Problem 3** [10pts] Let $a > 0$ with $a \neq 1$. **Show that** $\frac{d}{dx}\left[a^x\right] = \ln(a)a^x$**.**

**Problem 4** [10pts] You are given standard trigonometric identities and $\lim_{h\to 0}\left[\frac{sin(h)}{h}\right] = 1$ and $\lim_{h\to 0}\left[\frac{\cos(h)-1}{h}\right] = 0$. **Prove that** $\frac{d}{dx}[\sin(x) = \cos(x)]$**.**

**Problem 5** [5pts] Given $y = x + [\cos(x)]^{\sin(x)}$ calculate $dy/dx$.

**Problem 6** [10pts] Calculate $dy/dx$ via the technique of logarithmic differentiation (do not simplify answer and you may use $y$ in your answer)

$$y = \frac{3e^{2x+1}(x+1)(x^2-3)^7}{\sqrt{1+\sin(x)}}$$

**Problem 7** [10pts] Suppose $(x+y)^3 = y^3 + 2x + 17$.

**(a.)** Calculate $dy/dx$ via the technique of implicit differentiation.

**(b.)** find the tangent line at $(1, 2)$.

**Problem 8** [5pts] Approximate $\sqrt[4]{17}$ by considering the linearization of $f(x) = \sqrt[4]{x}$ centered at $a = 16$.

**Problem** [2pts] Suppose the tangent line to $y = f(x)$ at $x = 2$ has equation $y = 42 + 13(x - 2)$. Find the equation of the normal line to $y = f(x)$ at $x = 2$.

**Problem 9** [5pts] Argue for or against the following claim: "$f$ is a differentiable function on $\mathbb{R}$" where $f$ is given as follows:

$$f(x) = \begin{cases} \cos(x) + 1 & if\ x < \pi/2 \\ \cos(x) - 1 & if\ x \geq \pi/2 \end{cases}$$

**Problem 10** [5pts] Suppose some guy named Frank tells you that $P = mv$. If you are given that $\frac{dP}{dt} = 10$ and $\frac{dv}{dt} = 3$ when $m = 1$ and $v = 2$ then at what rate is $m$ changing?

**Problem 11** [15pts] Suppose that three sticks are joined to make a triangle. Furthermore, suppose these three sticks of lengths $A, B, C$ are placed on a flat surface. Label the angles of this triangle by $\alpha, \beta, \gamma$ which are opposite sides $A, B, C$ respective. You observe that $\alpha$ is increasing at rate of 1 degree per second and $\beta$ is decreasing at a rate of 3 degrees per second. **Find the rate of change of the area in this triangle.**

**IGNORE THIS, THE PROBLEM AS STATED IS IMPOSSIBLE**

**Problem 12** [5pts] If a function $f$ is continuously differentiable at $a \in dom(f)$ such that $f'(a) \neq 0$ then what does that tell you about the function? What interesting result follows given this data?

**Problem 13** [5pts] Let $p$ be a polynomial function of degree $n$ for some $n > 1$. Define $f(x) = p(x)e^{cx}$ where $c$ is a constant. Discuss how many horizontal tangents are possible for $f$ on $\mathbb{R}$.

**Problem** [10pts] Suppose that $u \in C^2(\mathbb{R})$ in this problem. Suppose $g(u) = \sinh(u^2)$. Define $h(x) = g(u(x))$.

1. calculate $\frac{dh}{dx}$
2. calculate $h''(x)$
3. does $y = h(x)$ have any horizontal tangents?