1. (24pts) The following problems are not related. Show all work.

(a)(12pts) Use the Quotient Rule to find $f'(x)$ if $f(x) = \frac{x^3}{1-x^2}$. Simplify your answer.

(b)(12pts) If $y = \sec^4(\pi \theta)$ find $dy/d\theta$. Simplify your answer.

2. (28pts) The following problems are not related. Show all work.

(a)(12pts) Suppose $y = f(x)$, use implicit differentiation to find $y'$ if $\cos(xy) = 1 - \sin(y)$.

(b)(12pts) Find the equation of the tangent line to $y = x^2 - x^4$ at the point $(1, 0)$. Simplify your answer.

(c)(4pts) Which of the choices below is equivalent to the limit $\lim_{x \to \pi/3} \frac{\cos(x) - 0.5}{x - \pi/3}$? Choose only one answer. No justification necessary, copy down the entire answer. If you do not copy down the entire answer, points will be deducted.

(A) $0$  (B) $+\infty$  (C) $\frac{1}{2}$  (D) $-\frac{\sqrt{3}}{2}$  (E) None of these

PROBLEMS #3 & #4 ON THE OTHER SIDE
3. (20pts) The following problems are not related. Show all work.

(a) (10pts) For what value(s) of $x \in [0, 2\pi]$ does $f(x) = x + 2\sin(x)$ have horizontal tangent?

(b) The position function of a particle is given by $s(t) = t^3 - 6t^2 + 9t$ where $t \geq 0$ is in seconds and distance is in feet. (i) (5pts) When is the particle at rest? (ii) (5pts) What is the total distance traveled by the particle in the first 2 seconds? Simplify your answer.

4. (28pts) The following problems are not related. Show all work.

(a) (12pts) Suppose $\cot(g'(x)) = x\pi^2 + 1$, find $g''(0)$.

(b) (12pts) If $f(x) = \begin{cases} \frac{x}{2}, & \text{if } x < 2 \\ \sqrt{2x}, & \text{if } x \geq 2 \end{cases}$, find $f'(x)$. Is $f(x)$ differentiable for all $x$? Explain.

(c) (4pts) Suppose the equation of the tangent line to the function $f(x) = ax^2 + bx$ at $(1, 1)$ is $y = 3x - 2$, then $a$ and $b$ are equal to which choice below? **Choose only one answer.** No justification necessary, copy down the entire answer. If you do not copy down the entire answer, points will be deducted.

(A) $a = 1, b = 1$ (B) $a = 2, b = -1$ (C) $a = 3, b = 4$ (D) $a = -3, b = 4$ (E) None of these

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