INSTRUCTIONS: Books, notes, and electronic devices are **not** permitted. Write (1) **your name**, (2) **1350/Exam 2**, (3) **lecture number/instructor name** and (4) **SPRING 2016** on the front of your bluebook. Also make a **grading table** with room for 4 problems and a total score. **Start each problem on a new page.** **Box** **your answers.** A correct answer with incorrect or no supporting work may receive no credit, while an incorrect answer with relevant work may receive partial credit. **Justify your answers, show all work.**

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1. The following problems are not related. Show all work, simplify your answers.

   (a)(8 pts) Find $\dfrac{d^2y}{dx^2}$ if $y = x\tan(x)$.

   (b)(8 pts) Suppose y is a function of x, find y' if $\cos(xy) = 1$.

   (c)(8 pts) Suppose $f(x) = \sqrt[3]{x + |x|}$, find $f'(x)$.

   (d)(5 pts) Which of the five choices given below is equivalent to $\dfrac{d}{dx}\left[\dfrac{f(x^2)}{x}\right]$? Clearly write down your answer(s) in your blue book, **no justification necessary** - *be sure to copy down the entire answer, don't just write down the roman numeral of your choice(s)*:

   (i) $2xf'(x^2)$ (ii) $\dfrac{2x^2f'(2^x) - f(x^2)}{x^2}$ (iii) $\dfrac{2x^2f'(x^2) - f(2x)}{x^2}$ (iv) $2f'(x^2) - f(x^2)x^{-2}$ (v) $2x^{-2}f'(x^2) - f(x^2)$

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2. (a)(10 pts) A vertical cylindrical tank with constant diameter of 10 meters contains a certain viscous fluid. At what rate will the fluid level inside the cylindrical tank change if we pump the fluid out at 3000 cubic meters per minute?

   (b) The Boulder Ball Bearing Company (BBBCO) produces steel ball bearings (spheres) with a volume of $32\pi/3\,\text{cm}^3$. (Recall that the volume of a sphere is $V = 4\pi r^3/3$ where r represents the radius.)

   (i)(10 pts) Use differentials to estimate the change in volume if the radius varies from $r = 2\,\text{cm}$ to $r = 1.9\,\text{cm}$.

   (ii)(5 pts) Show that the relative error of the volume of the ball bearing produced is 3 times the relative error of the radius of the ball bearing.

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3. The following problems are not related, remember justify your answers and cite any theorems you use.

   (a) Let $f(x) = \sqrt{x} - x/3$. (i)(6pts) Verify that $f(x)$ satisfies the three hypotheses of Rolle's Theorem on $[0, 9]$ and (ii)(6 pts) find all numbers c that satisfy the conclusions of Rolle's Theorem for $f(x)$ on $(0, 9)$.

   (b)(10 pts) Let $p(x) = (1 + x)^k$ for any number k. Use the linearization of $p(x)$ at $a = 0$ to establish the most important linear approximation for roots and powers, namely, $(1 + x)^k \approx 1 + kx$ for $x \approx 0$ and any number k.

PROBLEM #4 ON THE OTHER SIDE

4. The following problems are not related, remember to show all work and justify your answers.

(a)(8 pts) Find all the absolute extreme values of $f(x) = \sqrt{4 - x^2}$ for $-2 \leq x \leq 1$. (Be sure to write down the x-coordinate and the y-coordinate of all absolute extrema.)

(b)(8 pts) Find all local extreme values of $g(x) = x^{4/3} - 4x^{1/3}$. (Be sure to write down the x-coordinate and the y-coordinate of all local extrema.)

(c)(8 pts) In your blue book clearly sketch the graph of a function $h(x)$ that satisfies all the following properties (label all extrema, inflection points and asymptotes):

- $h(-2) = 2$, $h(0) = 0$, and $h(5) = 1$,
- $\lim_{x \to -\infty} h(x) = 0$, $\lim_{x \to 2^-} h(x) = -\infty$, and $\lim_{x \to 2^+} h(x) = +\infty$,
- $h'(x) < 0$ if $-2 < x < 2$ or $2 < x < 5$ and $h'(x) > 0$ if $x < -2$ or $x > 5$,
- $h''(x) > 0$ if $x < -3$ or $x > 2$ and $h''(x) < 0$ if $-3 < x < 2$.

THE LIST OF APPM 1350 LECTURE NUMBERS/INSTRUCTOR NAMES FOR THE FRONT OF YOUR BLUE BOOK:

Lecture #	Instructor	Class Time	Location
120	Murray COX	MWF 9-9:50	EDUC 220
130	Brendan FRY	MWF 10-10:50	ECCR 200
150	Brendan FRY	MWF 12-12:50	FLMG 102
170	Sujeet BHAT	MWF 2-2:50	ECCR 245
180	Sujeet BHAT	MWF 3-3:50	ECCR 116
340R	Ann DEFRANCO	MWF 8:30-9:20	WVN 181A
801	Sandra WILLIAMS	MWF 2-2:50	LRVN N101

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