INSTRUCTIONS: Books, notes, and electronic devices are **not** permitted. Write (1) **your name**, (2) **1350/Final**, (3) **lecture number/instructor name** and (4) **SPRING 2016** on the front of your bluebook. Also make a **grading table** with room for 5 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. (a)(8 pts) At what point on the curve $y = 1 + 2e^x - 3x$ is the tangent line parallel to the line $3x - y = 5$? Specify both the x and y coordinates.

   (b)(8 pts) Use the Squeeze Theorem to evaluate the following limit: $\lim_{x\to 0^+} \sqrt{x}e^{\sin(\pi/x)}$.

   (c)(8 pts) Find the absolute extrema of $g(x) = \ln(x^2 + x + 1)$ for $-1 \le x \le 1$. Specify both the x and y coordinates of all extrema.

   (d)(6 pts) Which of the five choices given below is equivalent to y' if $y = (\sin x)^{\ln(x)}$? Pick only one answer, **no justification necessary** - *be sure to copy down the entire answer, don't just write down the roman numeral of your choice*:

   $(i)\ \ln(x)\sin(x)^{\ln(x)-1}$ $\quad(ii)\ -\sin(x)^{\ln(x)}\cos(x)^{1/x}$ $\quad(iii)\ \sin(x)^{\ln(x)}\left[\frac{\ln(\sin x)}{x} + \ln(x)\tan(x)\right]$

   $(iv)\ \sin(x)^{\ln(x)}\left[\frac{\ln(\sin(x))}{x} + \ln(x^{\cot x})\right]$ $\quad(v)\ \frac{\ln(\sin(x))}{x} + \ln(x)\tan(x)$

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2. (a)(10 pts) Find the linearization of $f(x) = e^{-2x}$ at $a = 0$ and use it to approximate $e^{0.1}$.

   (b)(10 pts) Is $f(x) = \begin{cases} e^x + 1, & x < 0 \\ \log_2(x+1) + 2\cosh(x), & x \ge 0 \end{cases}$ continuous at $x = 0$? Use limits to answer this question.

   (c)(10 pts) If a snowball melts so that its surface area decreases at a rate of 1 cm^2/min, find the rate at which the diameter changes when the diameter is 10 cm. (Recall that if r is the radius then the surface area is $SA = 4\pi r^2$.)

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3. (a)(10 pts) Water leaks slowly from the bottom of a large storage tank at a rate of $r(t) = 100 - e^{2t}$ gallons per minute for $t > 0$. Find the amount of water that leaks from the tank during the first 10 minutes.

   (b)(10 pts) Find the area of the region bounded by the curve $y = \frac{x+1}{x^2+1}$ and the x-axis for $0 \le x \le \sqrt{3}$.

   (c)(10 pts) Evaluate the definite integral $\int_0^3 |x^2 - 4x + 3|\, dx$.

PROBLEMS #4 AND #5 ON THE OTHER SIDE

4. (a)(10 pts) Evaluate the limit: $\lim_{x\to\infty}(e^x + x)^{1/x}$.

(b)(10 pts) Use logarithmic differentiation to find the derivative of $y = \dfrac{\sqrt{x}e^{x^2}}{(x^2+1)^{10}}$.

(c)(10 pts) Suppose $f(x) = \int_e^{2x} e^t \ln(t+2)\,dt$, for $x > 0$. Find $(f^{-1})'(0)$.

(d)(5 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):

- $h(x)$ is odd, $h(0) = 0$ and $\lim_{x\to\infty} h(x) = -2$
- $h'(x) < 0$ if $0 < x < 2$ and $h'(x) > 0$ if $x > 2$,
- $h''(x) > 0$ if $0 < x < 3$ and $h''(x) < 0$ if $x > 3$.

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5. (25 pts) Answer either **ALWAYS TRUE** or **FALSE**. You do NOT need to justify your answer. (*Don't just write down "A.T." or "F", completely write out the words "ALWAYS TRUE" or "FALSE" depending on your answer.*)

(a)(5 pts) If we use a Riemann Sum with right endpoints and subintervals of equal length then

$$\int_0^1 x^2 + x\,dx = \lim_{n\to\infty} \frac{1}{n^3}\sum_{i=1}^{n}(i^2 + in)$$

(b)(5 pts) A bacteria culture initially contains 140 cells and grows at a rate proportional to its size and, after an hour, the population is 420. Based on this information the population will be 2800 bacteria at $t = \log_3(20)$ hours.

(c)(5 pts) According to the limit definition of the derivative $\dfrac{d}{dx}3^x = \lim_{h\to 0}\dfrac{3^x(3^h-1)}{h}$.

(d)(5 pts) $\sum_{n=1}^{4}\frac{1}{5}\left(\frac{1}{2}\right)^n = \frac{3}{8}$.

(e)(5 pts) Suppose a particle moves on a vertical line so that its coordinate at time t is $y = t^3 - 12t + 3$ for $t \geq 0$ then the particle starts moving upward after 1 seconds.

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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