INSTRUCTIONS: Books, notes, and electronic devices are **not** permitted. Fill out your bluebook properly including lecture number and instructor name. Also make a **grading table** with room for 6 problems and a total score. **Start each problem on a new page.** $\boxed{\text{Box}}$ **your final answers.** A correct answer with incorrect or no supporting work may receive no credit. **SHOW ALL WORK**

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1. (15 points) Evaluate the following:

   (a) $\displaystyle\int \frac{a+bx^2}{\sqrt{3ax+bx^3}}\,dx$ (b) $\displaystyle\int \frac{\cos\left(\frac{\pi}{x}\right)}{x^2}\,dx$ (c) $\displaystyle\int_0^{\frac{\pi}{4}} \frac{\sin(x)}{\cos^3(x)}dx$

2. (15 points) The expression $\displaystyle\lim_{n\to\infty}\sum_{i=1}^{n}\frac{4}{n}\sqrt{\frac{4}{n}i}$ describes the area of a region bounded by some function $f(x)$ on $1 \le x \le 5$ using subintervals of equal width and right endpoints.

   (a) What is the function $f(x)$?

   (b) Set up a definite integral to compute the area of the region.

   (c) Find the area of the region.

3. (12 points) Suppose that at any time t (seconds) the current i (amp) in an alternating current circuit is $i = 2\cos t + 2\sin t$. What is the peak (largest positive magnitude) current for this circuit?

4. The following questions are not related:

   (a) (12 points) The temperature T (degrees) inside a furnace is described by the function $T(t) = 1000 + 100\sin(\frac{\pi}{12}t + \frac{\pi}{6})$ where t is the time in hours, $t = 0$ corresponding to when the furnace is first fired up. Find the average temperature in the furnace during its first two hours of operation.

   (b) (12 points) Recalling that a function is constant on an interval if and only if its derivative is zero on that interval, show that the following function is constant on $(0, \infty)$.
   $f(x) = \displaystyle\int_0^{\frac{2}{x}} \frac{1}{t^2+1}dt + \int_0^{x} \frac{2}{t^2+4}dt.$

5. (14 points) A cyclist pedals along a straight road with velocity $v(t) = 2t^2 - 8t + 6$ miles per hour for three hours.

   (a) Find the displacement of the cyclist (in miles) on the time interval $[0, 3]$.

   (b) Find the distance traveled over the interval $[0, 3]$.

$\boxed{\text{MORE on the back page}}$

6. (20 points) Produce an answer with a short, succinct explanation. Box only your answer (not the explanation).

   (a) Consider using Newton's method to find the root of a function, $f(x)$. Suppose that for your initial guess, x_1, you discover that $f(x_1) = 0$. Assuming that $f'(x_1) \neq 0$ (and $f'(x_1)$ is defined), what is $f(x_3)$?

   (b) Which of the following statements (i, ii, iii, or iv) is NOT asking for the same information?

      i. Find the x-coordinates of the points where the curve $y = x^3 - 3x$ crosses the horizontal line $y = -1$.

      ii. Find the roots of $f(x) = x^3 - 3x - 1$.

      iii. Find the x-coordinates of the intersections of the curve $y = x^3$ with the line $y = 3x + 1$.

      iv. Find the values of x where the derivative of $g(x) = (\frac{1}{4})x^4 - (\frac{3}{2})x^2 - x + 5$ equals zero.

   (c) If $\displaystyle\int_0^\pi \cos(\sin x)dx = 2.4$, then $\displaystyle\int_{-\pi}^\pi \cos(\sin x)dx = ?$

   (d) For some function $h(x)$, it is known that $h'(x) = 2$ for all x in the interval $[0, 6]$ and $h(0) = -4$. Find $\displaystyle\int_0^6 h(x)dx$.

   (e) Is it true or false that there exists a c in $[1, 4]$ such that the rectangle with length 3 and height $\frac{c}{\sqrt{1+2c}}$ has an area of $\displaystyle\int_1^4 \frac{x}{\sqrt{1+2x}}dx$.

$\boxed{\text{END of Exam}}$