

**INSTRUCTIONS:** Books, notes, flying monkeys and electronic devices are not permitted. Write your (1) name, (2) instructor's name, and (3) recitation number on the front of your bluebook. Work all **6 problems**. Start each problem on a **new page**. Show your work clearly and box your final answer. A correct answer with incorrect or no supporting work may receive no credit, while an incorrect answer with relevant work may receive partial credit.

---

1. (20 points) Using appropriate rules of differentiation, find the following.

(a)  $f'(x)$  where  $f(x) = \frac{2x+1}{x^2-1}$

(b)  $\frac{d}{dx} (1 - 2x^3 - 3x^{-6} - \pi^2)$

(c) If  $u(0) = 5$ ,  $u'(0) = -3$ ,  $v(0) = -1$  and  $v'(0) = 2$ , find  $\frac{d}{dx}(uv)$  at  $x = 0$ .

2. (15 points) Answer the following questions as either **TRUE** meaning always true or **FALSE** meaning not always true. For this problem only, you do not need to justify your answer.

(a) A function can be both odd and even.

(b) If  $f$  is continuous at  $x_0$  then  $f$  is differentiable at  $x_0$ .

(c) If  $f$  is differentiable on  $(-\infty, \infty)$ ,  $f'(a) \geq 1$  and  $f'(b) \leq -1$  then there must be a point  $c$  with  $f'(c) = 0$ .

(d) If  $f(x)$  is even then  $g(x) = f(x) + 1$  is even.

(e)  $\sin(\frac{\pi t}{2})$  is an odd function.

3. (20 points) Find the following limits, if they exist. If the limit does not exist or is infinite, clearly state this. Show all your work and be sure to justify your answers.

(a)  $\lim_{x \rightarrow 0} x^2 \cos\left(\frac{9}{x}\right)$

(b)  $\lim_{x \rightarrow -2} \frac{(x+3)|x+2|}{x+2}$

(c)  $\lim_{h \rightarrow 0^+} \frac{\sqrt{h^2 + 4h + 5} - \sqrt{5}}{h}$

(d)  $\lim_{x \rightarrow 0} \sin\left(\frac{\pi}{2} + \tan x\right)$

4. (20 points)

(a) State the definition of the derivative,  $\frac{dy}{dx}$ .

(b) Using this definition, calculate the derivative with respect to  $x$  of  $y = \frac{1}{x-1}$ .

(c) Find equations of all lines having slope  $-1$  that are tangent to the curve  $y = \frac{1}{x-1}$ .

5. (10 points) Let  $f(x) = (\cos x)^2 - x$ . Show that  $f$  must have a root (or zero). You do not need to find the value of the root.

6. (15 points) A ball thrown vertically upward from a platform 56 feet above the ground at a velocity of 96 feet/second reaches a height of  $s = -16t^2 + 96t + 56$  feet in  $t$  seconds. Please state the units in your answer.

(a) Find the ball's velocity and acceleration at time  $t$ .

(b) How long does it take the ball to reach its maximum height?

(c) How high does the ball go?