Serial No: Student No.:   Name:

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1. SHOW ALL WORK. NO CREDITS FOR ANSWERS NOT SUPPORTED BY WORK.
2. CALCULATORS ARE NOT ALLOWED.

Problem 1 (25 Points): If the limit exists find it. If it does not exist, say so; use $\infty \; and \; -\infty$ when appropriate.

(a) $\displaystyle\lim_{x\to 1} \frac{x^2 + x - 2}{x^2 - 1}$

(b) $\displaystyle\lim_{x\to 0^+} \frac{x^2}{\sqrt{x^2 + 4} - 2}$

(c) $\displaystyle\lim_{x\to 3^+} \frac{-x^2}{9 - x^2}$

(d) $\displaystyle\lim_{x\to -\infty} \frac{2x^2 + 4x - 9}{1 + 3x - 3x^2}$

Problem 2 (25 Points)

(a) Use the definition of the derivative to find $f\,'(2)$ for the function $f(x) = x^2 + x$.

(b) Find the equation of the line tangent to the graph of $y = \sqrt{x} - \dfrac{2}{\sqrt{x}}$ at the point (1, -1).

(c) Find all points on the graph of $y = \dfrac{x^3}{3} - x^2$ where the slope is 3.

Problem 3 (25 Points)

(a) Find all values of **a** and **b** which will make the function $f(x)$ continuous.

$$f(x) = \begin{cases} 2x + 1 & if \; x < 2 \\ b & if \; x = 2 \\ x^2 + a & if \; x > 2 \end{cases}$$

(b) The demand equation of a certain product is $p = \dfrac{121}{q + 2} + 3$, where p is the price per unit and q denotes the number of units available. If the revenue function is $R(q) = pq$.

    (i)   Find the marginal revenue at $q = 20$.

    (ii)   Estimate the revenue from selling unit number 21.

    (iii) Find the relative rate of change in revenue when $q = 20$.

Problem 4 (25 Points):

(a) Find the derivative of $y = \dfrac{(x - 2)(1 + x^2)}{2x + 1}$ at $x = 2$.

(b) If $y = 3u^3 - u^2 + 7u - 2 \; and \; u = 5x - 2$, find $\dfrac{dy}{dx}$ when $x = 1$.

c) If $f(x) = \sqrt[5]{1 + \left(x^2 + 1\right)^3}$, find $f\,'(x)$. (Do Not Simplify the answer)