Please Show All Your Work, and Mark Your Answers Clearly.
No Calculators – No Scratch Paper – No Cell Phones

There are **9 pages** of problems. (The last 2 problems are for extra credit.)

**You are expected to do your own work, and to adhere to the UCD Code of Academic Conduct.**

**Simplify all numerical answers.**

In #17, use **interval notation**.

Give **units** for your answers where applicable.

In **max-min problems**, show whether your answer gives a max. or a min.

Please indicate clearly if you continue work on the back of a page.

Please stop working **immediately** when time is called.

**Have a Good Break!**
1) Find the derivatives of the following functions. (Do not simplify your answers.)

a) \[ f(x) = \ln \left( e^{x^2} + 5^x + 2x \right) \]

b) \[ f(x) = \left( \sin \frac{4x}{5} \right) \left( \tan^7 3x \right) \]

2) Find an equation of the tangent line to the graph of

\[ f(x) = \frac{x^2 - 1}{4x - 10} \quad \text{at} \quad (3, f(3)) \]
3 Use a linearization of \( f(x) = \sqrt[3]{x} \) to approximate \( \sqrt[3]{67} \).

4 Find the critical numbers and local extrema for \( f(x) = 6x^5 - 10x^3 \).

5 Find the absolute extrema for \( f(x) = x^{4/3} + 4x^{1/3} \) on \([-8, 1]\).
6. If \((a_n)\) is defined by the recursion formula \(a_{n+1} = \frac{5}{2} - \frac{1}{a_n}\), find all possible values for \(\lim_{n \to \infty} a_n\).

7. If there are 9 fruitflies initially, and if the number of fruitflies doubles every 36 minutes, when will there be 288 fruitflies? (Give units for your answer.)

8. Find the following limits:
   a) \(\lim_{x \to 0^+} x^4 \ln x\)
   b) \(\lim_{x \to \infty} (e^x + 9x)^{2/x}\)
Let \( f(x) = \frac{x^2 + 2x - 6}{x - 3} \).

1) Find an equation for the slanted asymptote to the graph of \( f \).

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8) Find the local extrema for \( f \).

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10) Find \( \frac{dy}{dx} \) for the curve \( x^5 + 8xy + 3y^3 = e^{4y} + x^3 \ln y \).

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11) Use Newton's method with \( x_1 = 1 \) to find a second estimate \( x_2 \) for the solution to the equation \( x^3 + 3x = 2 - 5\ln x \).
(a) Show that the equation \( x^3 + 3x^2 - 9x = -4 \)

\( a \) Has at least one solution in \([0, 1]\),

(b) Does not have more than one solution in \([0, 1]\).

(c) Use the definition of the derivative as a limit to find \( f'(x) \) for \( f(x) = \sqrt{x^2 + 5x} \).
Sketch the graph of a rational function \( f \) with the following properties:

1. \( x = 1 \) and \( x = 3 \) are the only vertical asymptotes.
2. \( y = 2 \) is a horizontal asymptote.
3. \( f(-1) = 0 \) and \( f(4) = -1 \) are local minima.
4. \( f(2) = 5 \) and \( f(-3) = 4 \) are local maxima.
5. \( (5, 1) \) is a point of inflection.

If \( f(x) = 4x - \frac{5}{x^2 + 12} \), determine where the graph of \( f \) is concave up or concave down.
(a) Find the slope-intercept form for the line which is tangent to the curve \( y = 6 \sqrt{x} \) and which passes through the point \((-4, -5)\).

(b) Find \( \lim_{x \to \infty} \left( \frac{2^{\frac{1}{x}} + 3^{\frac{1}{x}}}{2 + \frac{1}{x}} \right)^x \)