1) (20 points) Determine each of the following limits, finite or infinite. Show the details of your work and reasoning to support your answers and do not use numerical tables or graphs to approximate.

(a) \( \lim_{x \to -2} \frac{3x^2 - 12}{x^2 - 5x - 14} \)

(b) \( \lim_{x \to \infty} \frac{\sqrt{5x^4 + 1}}{3x^2 + 2x - 9} \)
2) (20 points) Let \( f(x) = \frac{1}{3x + 1} \).

(a) Find the average rate of change of \( f(x) \) over the interval \([1, 3]\).

(b) Use the limit definition to find the derivative function \( f'(x) \). You will not receive credit if you use derivative formulas/rules.
3) (30 points) Find the derivatives of the following functions using differentiation rules and formulas. Simplify your answers.

(a) \( f(x) = \ln(10 + 5 \sin x - 7 \cos x) \)

(b) \( f(x) = \frac{e^{2x} - 1}{e^{3x} + 1} \)

(c) \( f(x) = \tan^{-1}(\sin^3 x) \)  
(Note: \( \tan^{-1} x = \arctan x \))
4) (20 points) Find an equation of the tangent line at the point $(1, -1)$ on the curve $C$ defined by the implicit equation $x^3 - 2xy + y^3 = 2$.

5) (20 points) A small radio transmitter (RFID) is mounted on the edge of a rotating disk with a center at the origin in the $xy$-plane and a radius of 2 meters. If the $x$-coordinate of the RFID is decreasing at the rate of 0.2 meters per second when the RFID is at the point $(\sqrt{3}, -1)$, at what rate is its $y$-coordinate changing at the same moment?
6) (20 points) Use Calculus to find the intervals on which \( f(x) = xe^{-x} \) is concave up or concave down, and find the coordinates of all inflection points of \( f(x) \).
7) (20 points) (a) Use Calculus to find the coordinates of the point on the curve $xy = 8$ in the first quadrant that is closest to the point $(0,0)$.
8) (15 points) The velocity of a moving particle is \( v(t) = \frac{5}{t^2 + 1} + 4\sin t + 3\cos t \) feet per second. Assuming that the initial position of the particle is \( s(0) = 2 \) feet, find the position function \( s(t) \).

9) (15 points) Evaluate the Riemann sum for \( f(x) = \sin x \), \( 0 \leq x \leq \pi \) with 4 subintervals of equal length and taking the sample points to be the right endpoints. Illustrate the Riemann sum with a diagram.
10) (20 points) Calculate the following integrals. Do not use decimals in your answers.

(a) \[ \int \frac{x^2 - 4x + 3}{5x^3} \, dx \]

(b) \[ \int_1^2 \frac{dx}{2 - 3x} \]