1. (36 pt) Evaluate the following limits.
   a) \( \lim_{x \to 2} \frac{\sqrt{x^2 + 5} + x - 5}{x - 2} \)
   b) \( \lim_{x \to 0} \frac{\tan(ax + 1)}{\sin(b^2x + 1)} \)
   c) \( \lim_{x \to -\infty} \frac{3x\sqrt{x^2 + 1}}{2x^2 + x} \)
   d) \( \lim_{t \to 1} \sqrt{t^3 - 2t + 1} \)
   e) \( \lim_{h \to 0} \frac{\tan(a^2 + 2ah + h^2) - \tan(a^2)}{h} \)
   f) \( \lim_{x \to 0} x\sin(g\left(\frac{1}{x}\right)) \)

2. (24 pt) Find the derivative of each of the following functions.
   a) \( f(x) = \frac{\sin(2x)}{2\tan(x) + 1} \)
   b) \( g(x) = e^{x^2} \sin(ax) \cos(bx) \)
   c) \( h(x) = \frac{\sin(\sin(e^{\sin(x)})))}{x^2 + 1} \)
   d) \( k(x) = \sqrt{1 + \sqrt{2 + \sqrt{x^2 + 3}}} \)

3. Let \( f(x) \leq g(x) \leq h(x) \) be functions.
   a) (5 pt) Write the \( \delta - \epsilon \) definition of the meaning of the statement “\( \lim_{x \to a} g(x) = L \)”.
   b) (3 pt) Show use the \( \delta - \epsilon \) definition to show that if \( \lim_{x \to a} f(x) = L = \lim_{x \to a} h(x) \), then \( \lim_{x \to a} g(x) = L \).

4. (12 pt) Use the definition of the derivative to compute the derivative of the following functions.
   a) \( f(x) = \frac{2x}{x+1} \)
   b) \( g(x) = F(ax + b) \), where \( F \) is a differentiable function.

5. (8 pt) Find all possible tangent lines to the curve \( f(x) = x^3 + 6x^2 + 8 \) that go through the point \((0, 0)\).

6. (10 pt) Consider the function \( f(x) = x^\frac{1}{3} \).
   a) Where is this function differentiable? Geometrically explain why the derivative does not exist at the origin.
   b) Suppose that the derivative of \( g(x) \) does not exist at \( x = a \). Does it follow that the derivative of \( f(g(x)) \) also does not exist at \( x = a \)?

7. (12 pt) A more realistic model of a falling ball (incorporating air resistance) might be
   \[
   s(t) = v_T(t + \frac{v_T}{g} e^{-\frac{t}{v_T}}) - \frac{v_T^2}{g}
   \]
   where \( t \) is time, \( s(t) \) is distance fallen, \( g \) is the constant acceleration due to gravity, and \( v_T \) is a constant called the terminal velocity.
   a) Find the velocity, \( v(t) \), of the falling ball and evaluate \( \lim_{t \to \infty} v(t) \).
   b) Find the acceleration, \( a(t) \), of the falling ball and evaluate \( \lim_{t \to \infty} a(t) \).