This test is closed-book and closed-notes. No calculator is allowed for this test. For full credit show all of your work (legibly!), unless otherwise specified.

1. **(10 points)** Given the function $f(x) = \frac{3x^3 \arctan x + 5x^2 - 10}{x^2 - 5x - 6}$, answer the following questions preparatory to sketching the functions.

   (a) **(7 points)** Describe, either in words or symbolically, the long-term behavior of the function in each direction.

   (b) **(3 points)** What is the domain of the function?

2. **(9 points)** Let $f(x) = -8 + 3x$.

   (a) **(1 point)** Find $\lim_{x \to 1} f(x)$.

   (b) **(8 points)** Using epsilon-delta methods, justify your result above.

1	/ 10
2	/ 9
3	/ 9
4	/ 16
5	/ 10
6	/ 9
7	/ 13
8	/ 24
9	/ (5)
Σ	/100

3. **(9 points)** Let $f(x) = \begin{cases} x+6 & \text{if } x \leq 2 \\ px^2 & \text{if } 2 < x < 5 \\ qx & \text{if } x \geq 9 \end{cases}$.
What choices of p and q will make this function continuous everywhere?

4. **(16 points)** Determine the domains of the following functions:

(a) **(4 points)** $f(x) = \arcsin(4x+1)$.

(b) **(4 points)** $g(t) = \frac{3\cos t}{t^2+1}$

(c) **(4 points)** $h(u) = \frac{\ln u+3}{u^2-9}$.

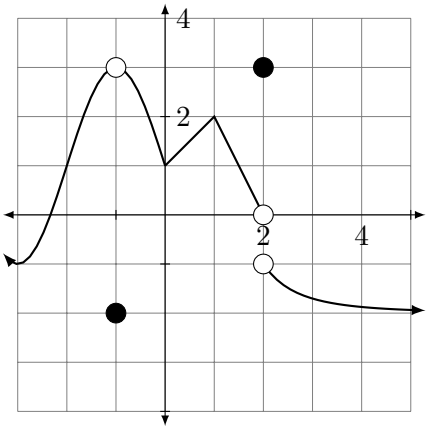
(d) **(4 points)** $s(t) = \sqrt{2t^2-72}$.

5. **(10 points)** Answer the following questions.

   (a) **(5 points)** For the function $f(x) = 5x^4 - 7e^x + \frac{8}{x^3} - 7x^2 + 1$, calculate its second derivative $f''(x)$.

   (b) **(5 points)** A falling object in a certain scenario is at a height of $100 - 16t^2 + 8\sqrt{t}$ feet after it has been falling for t seconds. What is its *velocity* after 2 seconds?

6. **(9 points)** For the plot of $f(x)$ shown below, indicate whether or not each of the following quantities can be evaluated. If they can be evaluated, compute their values. If they cannot be evaluated, explicitly say so. You need not show work.



$\lim_{x \to -1^-} f(x)$

$f(-1)$

$\lim_{x \to 0} f(x)$

$f(1)$

$\lim_{x \to 1^+} f(x)$

$\lim_{x \to 2^-} f(x)$

$\lim_{x \to 2^+} f(x)$

$f(2)$

$\lim_{x \to +\infty} f(x)$

7. **(13 points)** Let $f(x) = 6 + 2x - 3x^2$.

   (a) **(9 points)** *Using the difference quotient*, determine the formula for $f'(x)$.

   (b) **(4 points)** Find the equation of the tangent line to $f(x)$ at the point $(3, -15)$.

8. **(24 points)** Evaluate the following limits; when a limit can not be evaluated, explicitly say so.

   (a) **(4 points)** $\lim_{x\to 4} \frac{x^2-4x}{x^2-3x-4}$.

   (b) **(4 points)** $\lim_{s\to-\infty} \frac{3s^4-2s}{1+18s^2-2s^3}$.

   (c) **(4 points)** $\lim_{t\to 3} \frac{t^3-27}{t-3}$.

   (d) **(4 points)** $\lim_{q\to+\infty} \frac{4q^5-3q^2+2}{8+6q^3-7q^5}$.

   (e) **(4 points)** $\lim_{\theta\to 0} \frac{4\tan\theta+9}{2\cos\theta}$.

   (f) **(4 points)** $\lim_{u\to-\infty} \frac{u^2e^u-3}{8u^2-7u}$.

9. **(5 point bonus)** On the back of this page, provide a formal proof (using epsilon-delta form, or an analogue thereof) that $\lim_{x\to+\infty} x^3 = +\infty$.