1. Applications of the first derivative.

a) Find the interval(s) where the function is increasing and the interval(s) where the function is decreasing.

$f(x) = x^3 - 3x + 4$

$g(x) = \frac{1}{2x+3}$

$h(x) = (x-5)^{\frac{2}{3}}$

$r(x) = x\sqrt{x+1}$

b) Find any relative maxima and relative minima of the function.

$f(x) = x^3 - 3x + 6$

$g(x) = \frac{x}{x+1}$

$h(x) = x\sqrt{x-4}$

2. Applications of the second derivative.

a) Find any inflection points of the function, the interval(s) on which it is concave upward, and the interval(s) on which is is concave downward.

$f(x) = x^3 - x$

$g(x) = \frac{x}{1-x}$

$h(x) = 2 + \frac{3}{x}$

b) Determine if the given critical point(s) is a maximum or minimum using the given second derivative.

$x = 0,\ x = 1;\ f^{(2)}(x) = 2x - 1$

$x = 0;\ g^{(2)}(x) = 3x^2 + 1$

$x = 0;\ h^{(2)}(x) = -\frac{6(4x-3)}{(2x+3)^4}$

c) Sketch the graph of a function with the following properties: $f(0) = 0$, $f'(0)$ is undefined, and $f''(x) < 0$ if $x \neq 0$.

3. Find all asymptotes of the given function.

a) $f(x) = \frac{x+1}{2x-1}$

b) $g(x) = \frac{2x}{x^2+x-2}$

c) $h(x) = 1 + \frac{2}{x-3}$

d) $r(x) = \frac{1-x^2}{x^2+x}$

4. Find the absolute maximum and absolute minimum of the function over the given domain (when such extrema exist).

a) $f(x) = x^{\frac{2}{3}}$ over $\mathbb{R}$

b) $g(x) = \frac{x}{1-x}$ over $[2, 6]$

c) $h(x) = x^3 - 3x^2 - 1$ over $[0, 3]$

d) $f(x) = \frac{x}{x^2+1}$ over $\mathbb{R}$.

5. Optimization.

   a) A stone thrown straight up from the roof of an 80-ft building has a height after t seconds of $h(t) = -16t^2 + 64t + 80$ ft. What is the maximum height reached by the stone?

   b) The demand equation for a product is $p = -0.00042x + 6$ for $0 \leq x \leq 12,000$. The cost function for the same product is $C(x) = 600 + 2x - 0.00002x^2$ for $0 \leq x \leq 20,000$. How many should the company produce in order to maximize revenue?

   c) If an open box has a square base and a volume of 108 in^3, find the dimensions that minimize the amount of material in the box.

   d) Find the radius and height of a right circular cylinder with closed ends and a volume of 36 in^3 that has a minimum surface area.

   e) Suppose the cost incurred for operating a cruise ship for one hour at v mph is $a + bv^3$ dollars, where a and b are positive constants. What speed will minimize operating costs?

   f) A book is to have pages with a printed area of 54 in^2 and margins of 0.5 in on the top, bottom, and right sides, and a margin of 1 in on the left. What dimensions will minimize the amount of paper used per page?

4. Exponential functions.

   a) Simplify the expression:

      $(2x^3)(-4x^-2)$

      $\frac{(a^m a^{-n})^-2}{(a^{m+n})^2}$

   b) Solve the equation for x:

      $5^{-x} = 5^3$

      $4^{2x-1} = 4^{x+3}$

      $7^{x-x^2} = \frac{1}{49^x}$