1. Consider the function $f(x) = (x^3 - 3x^2 + 7)(x^4 - 2x^2 + 6x - 1)$. Applying the product and power rules, we find the derivative:

$$f'(x) = (x^3 - 3x^2 + 7)(4x^3 - 4x + 6) + (3x^2 - 6x)(x^4 - 2x^2 + 6x - 1).$$

2. Consider the function $f(x) = e^{2x}\cos(3x)$. Applying the product rule, we find the derivative:

$$f'(x) = -3e^{2x}\sin(3x) + 2e^{2x}\cos(3x) = e^{2x}(2\cos(3x) - 3\sin(3x)).$$

3. Consider the function $f(x) = x^2e^{-x} + 21\sqrt{x} = x^2e^{-x} + 21x^{\frac{1}{2}}$. Applying the product rule, we find the derivative:

$$f'(x) = -x^2e^{-x} + 2xe^{-x} + 21\left(\frac{1}{2}\right)x^{-\frac{1}{2}} = (2x - x^2)e^{-x} + \frac{21}{2\sqrt{x}}.$$

4. Consider the function $f(x) = \frac{1}{x^2}\ln(x) - e^{2x}(x^2 - 1) = x^{-2}\ln(x) - e^{2x}(x^2 - 1)$. Applying the product rule, we find the derivative:

$$f'(x) = x^{-2}\frac{1}{x} - 2x^{-3}\ln(x) - 2xe^{2x} - 2e^{2x}(x^2 - 1) = \frac{1}{x^3}(1 - 2\ln(x)) - 2e^{2x}(x^2 + x - 1)$$

5. Consider the function

$$f(x) = \frac{20\cos(7x)}{x^5} + (5x^5 + 11)\sin(2(x - 18)) = 20x^{-5}\cos(7x) + (5x^5 + 11)\sin(2(x - 18)).$$

Applying the product rule, we find the derivative:

$$f'(x) = -140x^{-5}\sin(7x) - 100x^{-6}\cos(7x) + 2(5x^5 + 11)\cos(2(x - 18)) + 25x^4\sin(2(x - 18)).$$

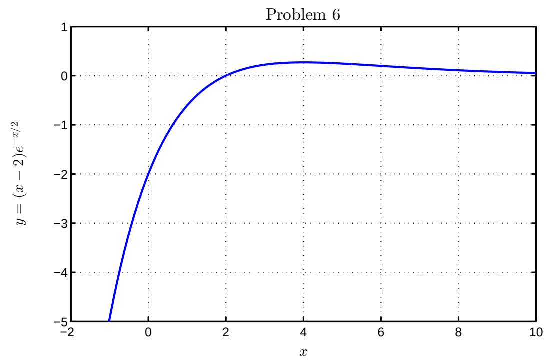
6. Consider the function $y = (x - 2)e^{-x/2}$. We find the derivative

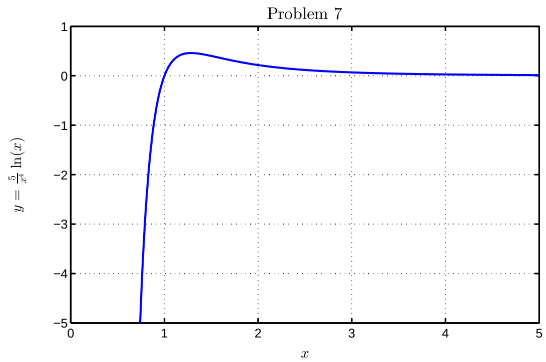
$$y'(x) = -\frac{1}{2}(x - 2)e^{-x/2} + 1 \cdot e^{-x/2} = \left(\frac{4 - x}{2}\right)e^{-x/2}.$$

The x-intercept is where $y = 0$, so $x = 2$. The y-intercept occurs where $x = 0$, so $y = -2$. Since the exponential function goes to zero faster than the term $(x - 2)$,

$$\lim_{x \to +\infty}(x - 2)e^{-x/2} = 0,$$

so there is a horizontal asymptote at $y = 0$ to the right. The critical point satisfies $y'(x) = 0$, so $x_c = 4$, which gives $y(x_c) = (4 - 2)e^{-2} \approx 0.2707$. This is a relative maximum at $(4, 2e^{-2})$. The graph is shown below to the left.





7. Consider the function $y = \frac{5}{x^4}\ln(x) = 5x^{-4}\ln(x)$. We find the derivative

$$y'(x) = 5x^{-4}\left(\frac{1}{x}\right) - 20x^{-5}\ln(x) = 5x^{-5}(1 - 4\ln(x)).$$

The domain is $0 < x < +\infty$, and there is a vertical asymptote where $x = 0$. Thus, there is no y-intercept. The x-intercept occurs where $y = 0$, so $\ln(x) = 0$ or $x = 1$. Since x^{-4} goes to zero faster than the term $\ln(x)$,

$$\lim_{x\to+\infty} 5x^{-4}\ln(x) = 0,$$

so there is a horizontal asymptote at $y = 0$ to the right. There is a critical point where $y'(x) = 0$, or $1 - 4\ln(x) = 0$. Thus, $x_c = e^{\frac{1}{4}} \approx 1.28403$ and $y(x_c) \approx 5(1.28403)^{-4}\ln(1.28403) \approx 0.45985$. This is a relative maximum at $(e^{1/4}, \frac{5}{4}e^{-1})$. The graph is shown above to the right.

8. Consider the function $y = (x^2 - 3)e^x$. We find the derivative

$$y'(x) = (x^2 - 3)e^x + (2x)e^x = (x^2 + 2x - 3)e^x = (x + 3)(x - 1)e^x.$$

The x-intercepts occur where $y = 0$, so $x^2 - 3 = 0$ or $x = \pm\sqrt{3}$. The y-intercept occurs where $x = 0$, so $y = -3$. Since the exponential function goes to zero faster than the term $(x^2 - 3)$, as $x \to -\infty$,

$$\lim_{x\to-\infty} (x^2 - 3)e^x = 0,$$

so there is a horizontal asymptote at $y = 0$ to the left. There are critical points where $y'(x) = 0$ or $(x + 3)(x - 1) = 0$. Thus, $x_{1c} = -3$ and $x_{2c} = 1$. Then $y(x_{1c}) = (9 - 3)e^{-3} \approx 0.298722$ is a relative maximum at $(-3, 6e^{-3})$ and $y(x_{2c}) = (1 - 3)e^1 \approx -5.4366$ is a relative minimum at $(1, -2e^1)$. The graph is shown below to the left.