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[12] 1. Compute each limit, if it exists.

(a) $\lim_{x \to 1/3} \dfrac{(2-6x)^2}{(3x-1)(9x^2-1)}$

(b) $\lim_{x \to \infty} \left(\sqrt{x^2+x} - \sqrt{x^2-3x} \right)$

(c) $\lim_{x \to 0} \dfrac{x^2+2x-\sin 3x}{2x}$

[8] 2. Find $f'(x)$ for each of the following functions. Do NOT simplify your answers.

(a) $f(x) = \sqrt{5 - 2\sin^3(7x)}$

(b) $f(x) = \dfrac{\ln(x^3 + x)}{e^{4\cos(x)}}$

[10] 3. Find the equation of the tangent line to the curve $3x^5y^5 - y = 2x$ at the point $(1, 1)$.

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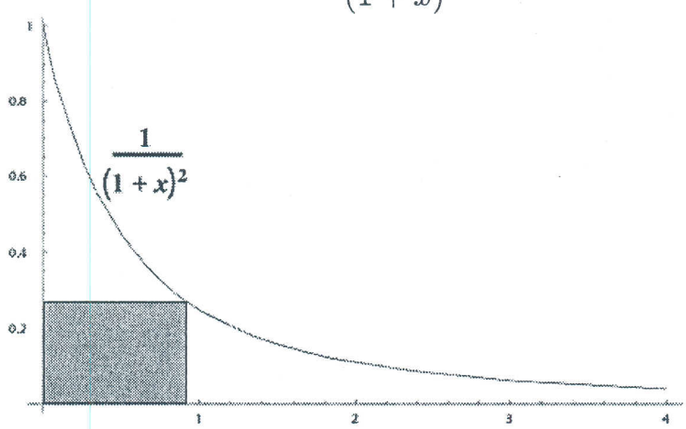
[20] 4. (a) Draw the graph of the function $f(x) = x^2e^{-x}$. (You may use the fact that $\lim_{x\to\infty} x^2e^{-x} = 0$ without proving it.)

(b) Find all points of inflection on this graph, and determine all intervals where the graph of the function is concave upward.

(c) Find the absolute maximum and minimum values of the function $f(x) = x^2e^{-x}$ on the interval $-1 \leq x \leq 3$.

[12] 5. Find the area of the largest rectangle that lies entirely in the first quadrant, has one side on the x-axis, another side on the y-axis, and a vertex on the curve $y = \dfrac{1}{(1+x)^2}$.



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[10] 6. At noon a ship S_1 is 20 km north of ship S_2. If S_1 sails south at 6 km/h and S_2 sails east at 8 km/h. How fast are the ships separating at 4 : 00 pm?

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[20] 7. Find the following indefinite and definite integrals:

(a) $\displaystyle\int t^2 \cos(t^3)\, dt$

(b) $\displaystyle\int \frac{\sqrt{x} - x^2}{x}\, dx$

(c) $\displaystyle\int_{\pi/2}^{\pi} \left(\sin x - \frac{1}{x}\right) dx$. Simplify as much as possible.

(d) $\displaystyle\int_0^1 x^5 \sqrt{x^3 + 1}\, dx$

[8] 8. Find $f(x)$ if $f''(x) = 36x^2 + 12x$ with $f'(1) = 19$ and $f(1) = 7$.

[8] Bonus. Find the points on the curve $y^2 - x^2 + 2x = 10$ closest to the point $(5, 0)$.