

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.

Answers may include all arithmetic operations, trigonometric functions, inverse trigonometric functions, and natural logarithms. Algebraic simplification of answers is unnecessary.

The problems are in no particular order, and it is suggested that you look at all of them before beginning to answer any.

1. **(8 points)** The *right strophoid* is a curve satisfying the equation $xy^2 + 5y^2 = 5x^2 - x^3$.

(a) **(6 points)** Find a formula for $\frac{dy}{dx}$ on this curve.

(b) **(2 points)** Find the equation of the tangent line to the curve at $(-3, 6)$.

2. **(6 points)** Calculate $\frac{d}{dx} \csc(x^2 \tan x)$.

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3. **(8 points)** Imre is twelve miles north of the Parliament, jogging southwards at six miles per hour; János is five miles to the east of Parliament, walking eastwards at three miles per hour.

(a) **(6 points)** Is the distance between Imre and János increasing or decreasing, and at what rate?

(b) **(2 points)** In an hour, will the distance between Imre and János increasing or decreasing, and at what rate?

4. **(6 points)** Find an equation of the tangent line to the curve $y = \frac{x+1}{x-1}$ at $(2, 3)$.

5. **(6 points)** If $f(x) = \frac{e^{\arcsin x}}{\ln x}$, then find $f'(x)$.

6. **(6 points)** Answer the following derivative-related questions.

(a) **(2 points)** Find $\frac{d}{dt} \frac{\sqrt{t}}{\cos t}$.

(b) **(4 points)** If $y = \arctan \sqrt{e^x}$, find $\frac{dy}{dx}$.

(c) **(2 points)** If $f(s) = s^3 \sec s$, find $f'(s)$.

7. (4 points) Estimate the following values using appropriate linear approximations.

(a) (2 points) $(1.03)^7$.

(b) (2 points) $\sqrt[3]{7.95}$.

8. (4 points) Find the absolute maxima and minima of the function $f(x) = \frac{x^2+3}{x+1}$ on the interval $[0, 5]$.