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1. (30pts)

For each of the following functions, find its domain and range, then draw its graph.

a. \( y = x^2 - x. \)

b. \( y = \sqrt{2x - x^2}. \)

c. \( y = \cos(2x) - 1. \)
2. (30pts)

Suppose \( \cos \theta = \frac{2}{5} \) and \(-\frac{\pi}{2} < \theta < 0\). Find the values of the \( \sin \theta \), \( \tan \theta \), \( \sec \theta \), \( \cot \theta \) and \( \csc \theta \).
3. (30pts)
(a) State the product law for limits.

(b) If
\[ \lim_{x \to 0} \frac{f(x)}{x^2} = 1, \]
then what is
\[ \lim_{x \to 0} f(x)? \]

(c) If
\[ x + 1 \leq f(x) \leq e^x \]
for all \( x \). Find \( \lim_{x \to 0} f(x) \), stating any results you use.
4. (30pts)

Plot the graph of a function satisfying the following: $f(0) = 0$, $\lim_{x \to 2} f(x) = \infty$, $\lim_{x \to 1^-} f(x) = -\infty$, $\lim_{x \to 1^+} f(x) = 0$, $\lim_{x \to \infty} f(x) = \infty$, $\lim_{x \to -\infty} f(x) = 0$. 
5. (30pts)

Differentiate the following functions.

(a) \( \frac{e^x - e^{-x}}{e^x + e^{-x}} \).

(b) \( \sin(\sqrt{x^2 + 1}) \).

(c) \( x^{\tan x} \).
6. (30pts)

Let the curve $C$ be given by the implicit equation

$$x^2 + y^2 = (2x^2 + 2y^2 - x)^2.$$ 

Find the tangent to the curve $C$ at the point $(x, y) = (0, -\frac{1}{2})$. 
A particle is moving along the curve $xy = 1$. As the particle passes through the point $(\frac{\sqrt{3}}{2}, \frac{2}{\sqrt{3}})$, its y-coordinate increases at a rate of $2\text{cm/s}$.

(a) What’s the rate of change of $x$-coordinate at this instant?

(b) How fast is the distance from the particle to the origin changing at this instant?
8. (30pts)

Compute the following limits.

(a) \( \lim_{t \to 0} \frac{\sin 3t}{\tan 6t} \)

(b) \( \lim_{x \to \infty} (\sqrt{x+1} - \sqrt{x}) \)

(c) \( \lim_{x \to \infty} x^{\frac{1}{x}} \)
9. (30pts)

Evaluate

(a) \[ \int_1^{\sqrt{3}} \frac{d}{dx} \left( \ln(\tan^{-1} x) \right) dx \]

(b) \[ \frac{d}{dx} \int_{x^2}^{\sqrt{3}} \ln(\tan^{-1} t) dt \]
10. (30pts)

Evaluate the following definite and indefinite integrals

(a) \[ \int_{0}^{\pi} |\cos x| \, dx. \]

(b) \[ \int_{-1}^{1} \frac{\sin(3x)}{1 + x^2} \, dx. \]

(c) \[ \int \frac{\sin(2x)}{1 + \sin^2 x} \, dx. \]