Instruction: Read each question carefully. Explain **ALL** your work and give reasons to support your answers.

*Advice*: DON’T spend too much time on a single problem.

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1. (9 pts.) (a) Find the indefinite integral
\[ \int \frac{t^3}{t^2 - 1} \, dt. \]

(9 pts.) (b) Evaluate the following improper integral.
\[ \int_0^\infty e^{-2x} (x + 1) \, dx \]
2. Evaluate each of the following indefinite integrals.

(9 pts.) (a) \[ \int e^{\sec x} \sec x \tan x \, dx \]

(9 pts.) (b) \[ \int \sqrt{x} \ln x \, dx \]
(20 pts.) 3. Find the volume of the solid formed when the region bounded by the curve $y = \arctan x$, the axis $y = 0$, and the line $x = 1$ is revolved around the $y$-axis. [First sketch a picture of the region.]
4. Consider the following Initial Value Problem.

\[ y' = \frac{1 + y^2}{x}, \quad y(1) = 0. \]

(a) Use the method of separation of variables to solve this IVP.

(b) Estimate the value \( y(2) \) (when \( x = 2 \)) of the solution using Euler’s method with two steps with initial point \((1,0)\). DO THIS BY HAND.
5. Determine whether each of the following series converges or diverges. Justify your answer.

(9 pts.) (a) 
\[ \sum_{n=1}^{\infty} \frac{3}{\sqrt{n}} \]

(9 pts.) (b) 
\[ \sum_{n=1}^{\infty} \frac{n(n - 1)}{2n^2 + n + 5} \]
6. For each of the following series, determine whether the series converges absolutely, conditionally, or neither.

(9 pts.) (a) \[ \sum_{n=0}^{\infty} \frac{(-1)^n 5^n n!}{(2n)!} \]

(9 pts.) (b) \[ \sum_{n=0}^{\infty} \frac{(-1)^n}{n + 3} \]
7. 

(10 pts.) (a) Let \( f(x) = e^{\cos x} \). Find the second degree Maclaurin polynomial for \( f(x) \).

(10 pts.) (b) Use the Maclaurin series representation for \( \frac{1}{1-x} \) to find the Maclaurin series for \( g(t) = \frac{1}{1+t^3} \).
8. (10 pts.) (a) Find the radius of convergence for the following power series.

\[ \sum_{n=0}^{\infty} \frac{x^n}{5^n} \]

(b) For what values of \( x \) is the following power series convergent? [Don’t forget to check the endpoints.]

\[ \sum_{n=0}^{\infty} \frac{(-1)^n x^n}{n3^n+1} \]