1. (10 pts) Draw a right triangle and use it to simplify the expression: \( \tan(\sin^{-1}(\frac{y}{2})) \)

2. (10 pts) Differentiate with respect to \( x \): \( f(x) = x \arctan x \).

3. (10 pts each) Evaluate the following limits. Indicate indeterminate forms where appropriate.

   a) \( \lim_{x \to 0} \frac{1 - \cos 2x}{x^2} \)

   b) \( \lim_{x \to \infty} x^{1/x} \)
4. (10 pts each) Evaluate the following integrals. Show all your work.

a) \( \int \tan^{10} x \sec^4 x \, dx \)

b) \( \int \sqrt{100 - x^2} \, dx \)

c) \( \int \frac{x - 5}{x^2(x + 1)} \, dx \)
d) \( \int x^2 \sin 2x \, dx \)

5. (10 pts) Find a general solution to the differential equation: \( \frac{dy}{dt} = 2y + 6. \)

6. (10 pts) Evaluate the following improper integral or show that it diverges: \( \int_0^\infty \frac{dx}{(x + 2)^3} \)
7. (10 pts) Determine whether the following series converges or diverges. State the test used, apply the test showing all your work and state the result: \[ \sum_{k=1}^{\infty} \left( \frac{k}{3k + 1} \right)^{2k} \]

8. (10 pts) Find the radius and open interval of convergence of the following series: \[ \sum_{n=1}^{\infty} \frac{(x + 2)^n}{n \cdot 3^n} \]

9. (10 pts) Determine whether the following series converges absolutely, converges conditionally or diverges: \[ \sum_{k=1}^{\infty} \frac{(-1)^{k+1}}{k^{3/2}} \]
10. (a) (10 pts) Find the first 4 non-zero terms of the Taylor series for \( f(x) = e^{-x} \) centered about \( a=0 \).

(b) (5 pts) Write the above series in sigma notation.

11. (15 pts) Find the length of the curve: 
\[ x = 3t^2 + 1, \quad y = 4 + 2t^3, \quad 0 \leq t \leq 1 \]

12. (10 pts) Simplify the expression \( \sinh x - \cosh x \).
13. (a) (10 pts) Sketch the curve $r = 1 + \sin \theta$.

(b) (10 pts) Find the area of the region enclosed by the above curve in the first quadrant.

(c) (10 pts) Find $\frac{dy}{dx}$ for the curve in part (a) when $\theta = \frac{\pi}{6}$.

Total (out of 200 points):