1. Write out the partial fraction decomposition of each function. Do not determine the numerical values of the coefficients.
   (a) \( \frac{2}{(x - 1)(x + 1)} = \) 
   (b) \( \frac{4x^2 + 3x - 1}{x(x^2 + 1)} = \) 
   (c) \( \frac{2x}{(x - 1)(x - 2)^2} = \) 

2. Evaluate \( \int \sin^2 x \cos^3 x \, dx \) 

3. Use a trig substitution to evaluate \( \int \frac{dt}{t^2 \sqrt{t^2 - 16}} \) 

4. Evaluate the integral using partial fractions:
   \( \int \frac{5x + 1}{(2x + 1)(x - 1)} \, dx \) 

5. Use the Comparison Theorem to determine whether the integral is convergent or divergent.
   \( \int_1^\infty \frac{3 + \sin x}{\sqrt{x}} \, dx \) 

6. Determine if the integral is convergent or divergent. Evaluate if convergent.
   \( \int_3^\infty \frac{dx}{(x - 2)^{3/2}} \) 

7. Evaluate
   \( \int \frac{dx}{(1 - x^2)^{3/2}} \) 

8. Evaluate
   \( \int_1^3 r^4 \ln r \, dr \)
9. Evaluate
\[ \int te^{-3t} \, dt \]

10. Use integration by parts to evaluate
\[ \int e^{-\theta} \cos 2\theta \, d\theta. \]

11. (12 points) Determine if the series converges or diverges using the \( n \)th Divergence Test.
   (a) (8 points) Calculate the limit.
   \[ \lim_{n \to \infty} \frac{n}{\sqrt{n^2 + 16}} \]

   (b) (4 points) Use this limit to determine if the series \( \sum_{n=1}^{\infty} \) converges or diverges.
   Does the series converge or diverge? **Circle the correct answer.**
   1. Because the limit is finite, the series converges by the \( n \)th Term Divergence Test.
   2. Because the limit is infinite, the series diverges by the \( n \)th Term Divergence Test.
   3. Because the limit is finite and nonzero, the series diverges by the \( n \)th Term Divergence Test.

12. Calculate the arc length, \( s \) of the function \( y = 12x^{3/2} \) over the interval \([1, 2]\).

13. A plate in the shape of an isosceles triangle with base 1 meter and height 10 meters is submerged vertically in a tank of water so that the top of the triangle is located 3 m below the surface of the water. Calculate the total fluid force \( F \) on a side of the plate. The acceleration for gravity is 9.8 \( m/s^2 \) and the density of water is 1000 \( kg/m^3 \).

14. Compute the surface area of revolution about the \( x \)-axis over the interval \([0, 8]\) for \( y = x \).

15. Consider the series.
   \[ \frac{14}{3^3} + \frac{14}{3^4} + \frac{14}{3^5} + \frac{14}{3^6} + \cdots \]
   This can be written as a geometric series in the form \( \sum_{n=0}^{\infty} cr^n \). Identify \( c \) and \( r \) in the geometric series.
   \[ c = \quad \text{___________}, \quad r = \quad \text{___________} \]
Calculate the sum of the series

\[
\frac{14}{3} + \frac{14}{3^2} + \frac{14}{3^3} + \frac{14}{3^4} + \cdots =
\]

16. Calculate \( S_3 \), \( S_4 \), and \( S_5 \), and then find the sum \( \sum_{n=1}^{\infty} \frac{1}{4n^2 - 1} \) using the identity

\[
\frac{1}{4n^2 - 1} = \frac{1}{2} \left( \frac{1}{2n - 1} - \frac{1}{2n + 1} \right)
\]

\( S_3 = \) ____________________________

\( S_4 = \) ____________________________

\( S_5 = \) ____________________________

\[
\sum_{n=1}^{\infty} \frac{1}{4n^2 - 1} = \) ____________________________

17. Determine if the series converges or diverges. Find the sum if possible.

\[
\sum_{n=2}^{\infty} e^{1-4n}
\]

18. Determine the limit of the sequence and state if the sequence converges or diverges

\[
a_n = \ln \left( \frac{2n + 9}{-8 + 5n} \right)
\]

19. Determine if the series converges or diverges.

\[
\sum_{n=1}^{\infty} \frac{n}{10n + 12}
\]

20. Use the Squeeze Theorem to determine the limit of the sequence

\[
a_n = \frac{\sin n}{\sqrt{n}}
\]
21. Use the Limit Comparison Test to test the series for convergence or divergence

\[ \sum_{n=1}^{\infty} \frac{1}{ \sqrt{n^2 - 1} } \]

22. Use the Integral Test to determine if the series converges or diverges.

\[ \sum_{n=2}^{\infty} \frac{1}{ n \sqrt{\ln n} } \]

23. Find the interval of convergence of the series

\[ \sum_{n=0}^{\infty} \frac{(x - 2)^n}{n^2 + 1} \]

24. Use the Root Test to test the convergence of the series \( \sum_{n=1}^{\infty} \left( \frac{2n + 3}{3n + 2} \right)^n \).

25. Compute the 3rd degree Taylor polynomial, \( T_3 \) for \( f(x) = 3\sqrt{x} \) centered at \( a = 1 \).

26. Determine whether the series is absolutely convergent, conditionally convergent, or divergent \( \sum_{n=1}^{\infty} (-1)^{n-1} \frac{n}{n^2 + 4} \).

27. Evaluate the indefinite integral as an infinite series

\[ \int \frac{\cos x - 1}{x} \, dx \]

28. Use series to evaluate the limit. (Do not use l’Hospital’s rule)

\[ \lim_{x \to 0} \frac{x - \ln(1 + x)}{x^2} \]

29. Test the series for convergence or divergence

\[ \sum_{n=1}^{\infty} \frac{3^n n^2}{n!} \]

30. Test the series for convergence or divergence

\[ \sum_{n=1}^{\infty} \frac{1}{5 + 4^n} \]
31. Find $\frac{dy}{dx}$ for $\left(\ln(t), \frac{1}{t}\right)$ at $t = 7$.

32. Find $\frac{dy}{dx}$ for $(\sec \theta, \tan \theta)$ at $\theta = \frac{3\pi}{4}$.

33. Calculate the arc length integral $s$ for the logarithmic spiral
   
   $$c(t) = (e^t \cos(t), e^t \sin(t))$$

   for $0 \leq t \leq 7$

34. Compute the surface area of the cone generated by revolving $c(t) = (t^2, t)$ for $0 \leq t \leq 2$

35. Convert to an equation in rectangular coordinates
   
   $$r = 3 \csc(\theta) - \sec(\theta)$$

36. Convert the equation $r = 4 \sec(\theta)$ from polar coordinates to rectangular coordinates