1. Find the volume of the solid generated when the region bounded by \( y = e^x \), \( y = e \), and \( x = 0 \) is rotated about the \( x \)-axis. Use washer method.

2. Evaluate \( \lim_{x \to \infty} \frac{\ln x}{\sqrt{x}} \).

3. Find the derivative of \( y = \tan^{-1}(e^x) + e^{\sin^{-1} x} \).
4. Find the derivative of \( y = (1 + x^2)^x \).

5. The half-life of Radium-226 is 1590 years. Suppose you have a 100-mg sample. When will the mass be reduced to 15-mg?

6. Evaluate \( \int \cos^4 x \sin^3 x \, dx \).
7. Evaluate $\int x \ln x \, dx$.

8. Evaluate $\int \frac{1}{x \sqrt{9-x^2}} \, dx$.

9. Evaluate $\int \frac{x-9}{(x+5)(x-2)} \, dx$. 
10. Write the definition and evaluate the improper integral \( \int_{1}^{\infty} xe^{-x^2} dx \) if it is convergent.

11. Find the length of \( y = \ln(\cos x) \), \( 0 \leq x \leq \pi/3 \).

12. Given \( f(x) = 2x^3 + 5 \), show that \( f \) is one-to-one and find \( f^{-1} \).
13. Determine whether the series $\sum_{n=1}^{\infty} \frac{3^n}{n!}$ is convergent or divergent (mention the theorem you use).

14. Determine whether the series $\sum_{n=1}^{\infty} (1 + \frac{1}{n})^n$ is convergent or divergent (mention the theorem you use).

15. Show that the series $\sum_{n=1}^{\infty} \frac{(-1)^n 2^n}{3^n + 1}$ is a convergent geometric series and find the sum.
16. Determine whether the series $\sum_{n=1}^{\infty} (-1)^n \frac{n}{n^2 + 1}$ is absolutely convergent, conditionally convergent, or divergent (mention the theorems you use).

17. Determine whether the series $\sum_{n=1}^{\infty} \ln \frac{n}{n+1}$ is convergent by definition.

18. Find the interval of convergence for $\sum_{n=1}^{\infty} \frac{(x-3)^n}{\sqrt{n}}$. 
19. Find the 3rd-degree Taylor polynomial of $\sqrt{2x+1}$ at $a = 0$.

20. Find the Maclaurin series for $\sin x^2$ and use it to evaluate $\int \sin x^2 \, dx$. 