1. Evaluate the integrals: 
(a) \( \int e^x \cos(x) \, dx \) 
(b) \( \int \frac{x}{x^2 - 2x - 3} \, dx \) 
(c) \( \int \frac{\sqrt{1 - x^2}}{x^4} \, dx \)

2. Determine if the integrals converge or diverge: 
(a) \( \int_0^1 (x+1)(x^2+2x)^{-1/2} \, dx \) 
(b) \( \int_1^\infty \frac{1}{e^x + 2x} \, dx \)

3. Let \( R \) be the region in the first quadrant bounded by \( x = y \) and \( x = \sqrt{y} \). 
(a) Find the volume of the solid generated by rotating the region \( R \) about the \( y \)-axis using the Washer Method. 
(b) Set up, but do not solve, an integral to find the volume of the solid generated by rotating the region \( R \) about the \( y \)-axis using the Shell Method.

4. Find the volume of the solid generated by revolving the region in the first quadrant bounded by \( y = e^{-x}, x = 1 \) and the coordinate axes about the line \( x = 1 \).

5. Find the centroid of the region bounded by \( y = e^x, x = 0, y = 0 \) and \( x = 1 \).

6. Solve the differential equations: 
(a) \( \frac{dy}{dx} + 2xy = 2x \) 
(b) \( (x^2 + 3x)y' = 1 \cos(y) \)

7. Determine if the given sequences converge or diverge: 
(a) \( a_n = \frac{\ln(n^2)}{n} \) 
(b) \( a_n = \sqrt{2n + 1} \)

8. Determine if the given series converge absolutely, conditionally or diverge. Determine the sum when possible. Show all work. 
(a) \( \sum_{n=1}^{\infty} \frac{(-1)^n}{2^n 3^n} \) 
(b) \( \sum_{n=1}^{\infty} \frac{2^n 3^n}{n^n} \) 
(c) \( \sum_{n=1}^{\infty} \tan(1/n) \) 
(d) \( \sum_{n=1}^{\infty} \frac{-2}{n^2 + n} \) 
(e) \( \sum_{n=2}^{\infty} \frac{(-1)^n}{\sqrt{n^2 - 1}} \)

9. Find the interval of convergence of: 
(a) \( \sum_{n=0}^{\infty} \frac{(n+1)x^{2n-1}}{4^n} \) 
(b) \( \sum_{n=0}^{\infty} \frac{(-1)^n(x-1)^{n+1}}{n+1} \)

10. Find the Maclaurin Series of: 
(a) \( \sin^2(x) \) 
(b) \( \frac{1}{(2 + x)^3} \)

11. (a) Use a series to approximate \( \int_0^1 \frac{\tan^{-1}(x)}{x} \, dx \) with an error of magnitude less than 0.0125. (Hint: 0.0125 = 1/80.) 
(b) What is the error of this approximation?

12. Use series to evaluate \( \lim_{x \to 0} \frac{\sin(x) - x + x^3/6}{2x^5} \)

13. (a) Find the Taylor polynomial of order 2, \( T_2(x) \), of \( f(x) = x^{3/4} \) centered at \( a = 16 \). 
(b) Use Taylor’s Formula to estimate the error of the approximation in part (a) if \( 15 \leq x \leq 17 \).

14. (a) Set-up the Trapezoidal Rule approximation \( T_6 \) of the integral \( \int_0^3 f(x) \, dx \) in terms of \( f(x) \).
(b) Set-up the Midpoint Rule approximation \( M_6 \) of the integral \( \int_0^3 f(x) \, dx \) in terms of \( f(x) \).
(c) If it is know that \( -4 \leq f''(x) \leq 1 \) for all \( x \), what is the error involved in approximating the integral \( \int_0^3 f(x) \, dx \) by \( M_7 \)? by \( T_5 \)?

15. Find a Cartesian equation for the given parametric equations and identify the shape of the graph: 
(a) \( x = t, \ y = -\sqrt{1+t^2}, \ t > 0 \) 
(b) \( x = 2 \sinh(t), \ y = 2 \cosh(t), \ -\infty < t < \infty \)
16. Given the curve \( C: x = \cos(t) + t \sin(t), \quad y = \sin(t) - t \cos(t) \) for \( 0 \leq t \leq \pi/2 \), (a) find the length of curve \( C \) and (b) set-up, but do not solve, an integral to find the surface area of the surface generated by rotating the curve \( C \) about the \( x \)-axis.

17. Find the length of the polar curve \( r = \theta^2 \) for \( 0 \leq \theta \leq \sqrt{5} \).

18. Given the curve \( C: x = \sec(t), \quad y = \tan(t) \), find \( \frac{d^2y}{dx^2} \) at \( t = \pi/6 \).

19. Find the slope of \( r = -1 + \cos(\theta) \) at \( \theta = \pi/2 \).

20. Find the area of the region enclosed by the inner loop of the curve \( r = 1 + 2 \sin(\theta) \).

21. Find the area of the region shared by \( r = 1 \) and \( r = 2 \sin(\theta) \).

22. Find the area of the region inside the rose curve \( r = 2 \cos(2\theta) \) and outside the circle \( r = 1 \).

23. Sketch the graph with vertices, foci and asymptotes: (a) \( \frac{(x-2)^2}{4} + \frac{(y-3)^2}{9} = 1 \) (b) \( \frac{y^2}{e^2} - \frac{x^2}{\pi^2} = 1 \)