1. Evaluate the given integral

(a) \[ \int 3xe^{-x^2} \, dx \]

(b) \[ \int 3\sqrt{x} \ln x \, dx \]

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

(e) \[ \int \frac{3x}{(1 + x^2)^2} \, dx \]

(f) \[ \int_0^1 2x \arctan x \, dx \]
2. Determine the area bounded by the curves $f(x) = 4^x$ and $g(x) = 3x + 1$.

3. Determine the area bounded by the $x$-axis, the $y$-axis, the line $y = 3$ and the curve $y = \sqrt{x - 2}$.
4. Calculate the volume obtained by rotating the region in the first quadrant bounded by \( f(x) = x^3 \) and \( g(x) = 2x - x^2 \) about the \( x \)-axis.

5. Calculate the volume obtained by rotating the region in the first quadrant bounded by \( f(x) = x^3 \) and \( g(x) = 2x - x^2 \) about the \( y \)-axis.
6. A 60-lb boulder is suspended over a roof by a 40-ft cable that weighs 10 lb/ft. How much work is required to raise the boulder with the cable over the roof, the distance of 40 ft?

7. A trough is filled with water and its vertical ends have the shape of a parabola with top length 8 ft and height 4 ft. Find the hydrostatic force on one end of the trough.
8. Determine the arclength of the curve \( y = \frac{1}{2}x^2 - \frac{1}{4}\ln x \) on \( 2 \leq x \leq 4 \)

9. Evaluate the integral if it converges. Show divergence otherwise.

(a) \( \int_1^3 \frac{2}{(x - 1)^2} \, dx \)

(b) \( \int_0^\infty \frac{2}{1 + x^2} \, dx \)
10. Solve the initial value differential equation explicitly for $y(t)$:

\[
\frac{dy}{dt} = 2(y - 1)^2 \quad \frac{1}{2}.
\]

11. Solve the initial value differential equation explicitly for $y(x)$:

\[
\frac{dy}{dx} = xy - x \quad y(0) = 10.
\]
12. Solve the initial value first order linear differential equation:

\[ y' = y + x \quad y(0) = 2. \]

13. Solve the initial value first order linear differential equation:

\[ xy' + y = 3x^2 \quad y(1) = 2. \]
14. Use Euler’s Method to approximate \( y(1) \) if \( \frac{dy}{dx} = y + x \) with \( y(0) = 1 \) and \( \Delta x = \frac{1}{2} \).

15. Use Simpsons Rule to approximate \( \int_{1}^{3} \frac{1}{x} \, dx \) with \( n = 4 \).
16. Solve the initial value second order homogeneous differential equation:

\[ y'' + 2y' + y = 0 \quad y(0) = 2 \quad y'(0) = 4. \]

17. Solve the initial value second order homogeneous differential equation:

\[ y'' + 4y = 0 \quad y(0) = 1 \quad y'(0) = 3. \]
18. Solve the initial value second order nonhomogeneous differential equation using the method of undetermined coefficients.

\[ y'' + 5y' + 4y = \sin x \quad y(0) = 0 \quad y'(0) = 0. \]
19. Tell whether the series converges or diverges and justify your answer by showing reason by a valid test.

(a) \[ \sum_{n=1}^{\infty} \frac{(-1)^n}{3n + 1} \]

(b) \[ \sum_{n=0}^{\infty} \frac{2^{3n}}{5^n} \]

(c) \[ \sum_{n=0}^{\infty} \frac{4}{n + 1} \]

(d) \[ \sum_{n=0}^{\infty} \frac{3}{n^2 + 1} \]
20. Determine the given sum:

(a) \( \sum_{n=1}^{\infty} \frac{5 \cdot 2^n}{3^n} \)

(b) \( \sum_{n=0}^{\infty} \frac{(-1)^n}{n!} \)

(c) \( \sum_{n=0}^{\infty} \frac{2}{n^2 + 4n + 3} \)

(d) \( \sum_{n=0}^{\infty} \frac{4}{n!} \)
21. Determine the Taylor Series about \( x = 0 \) for:

(a) \( f(x) = \frac{1}{1 + x} \)

(b) \( g(x) = \frac{1}{(1 + x)^2} \)

(c) \( h(x) = \frac{1}{1 + x^2} \)

(d) \( k(x) = \arctan x \)
22. Determine the fourth degree Taylor Polynomial about $x = 0$ for the function

$$f(x) = \sqrt{1+x}.$$ 

23. Determine the fourth degree Taylor Polynomial about $x = 1$ for the function

$$f(x) = \ln x.$$
24. Determine the interval and radius of convergence of the given series:

\[ \sum_{n=1}^{\infty} \frac{(x-1)^n}{3^n}. \]

25. Determine the interval and radius of convergence of the given series:

\[ \sum_{n=1}^{\infty} \frac{(x-1)^n}{n}. \]
26. Given points \( P(-1, 4, 6) \) and \( Q(-3, 6, 7) \) and \( R(-4, 7, -6) \),

(a) determine the angle \( \theta \) between \( \vec{PQ} \) and \( \vec{PR} \).

(b) Determine the equation of the plane which contains the points \( P, Q, \) and \( R \).

(c) Determine the volume of the parallelopiped formed by the vectors: \( \vec{OP}, \vec{OQ} \)
and \( \vec{OR} \) where \( O \) is the origin \((0, 0, 0)\).
27. Change coordinates:

(a) from rectangular coordinates to cylindrical coordinates.
   i. \( P(-3, 3, 6) \)
   ii. \( z = \sqrt{4x^2 + 4y^2} \)

(b) from spherical coordinates to rectangular coordinates.
   i. \( P(4, \pi/3, \pi/4) \)

(c) from rectangular to spherical coordinates.
   i. \( x^2 + y^2 + z^2 = 9 \)