1. Evaluate the given integral

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

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

   (c) $\int \dfrac{x+5}{x^2+x-2}\,dx$

   (d) $\int x\,\sin(\pi x)\,dx$

   (e) $\int \dfrac{3x}{(1+x^2)^2}\,dx$

   (f) $\displaystyle\int_0^1 2x\arctan x\,dx$

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 $y = \dfrac{1}{2}x^2 - \dfrac{1}{4}\ln x$ on $2 \le x \le 4$

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

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

(b) $\displaystyle\int_0^\infty \frac{2}{1+x^2}\,dx$

10. Solve the initial value differential equation explicitly for $y(t)$:

$$\frac{dy}{dt} = 2(y-1)^2 \qquad y(0) = \frac{1}{2}.$$

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

$$\frac{dy}{dx} = xy - x \qquad y(0) = 10.$$

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

$$y' = y + x \qquad y(0) = 2.$$

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

$$xy' + y = 3x^2 \qquad y(1) = 2.$$

14. Use Euler's Method to approximate $y(1)$ if $\dfrac{dy}{dx} = y + x$ with $y(0) = 1$ and $\Delta x = \dfrac{1}{2}$.

15. Use Simpsons Rule to approximate $\displaystyle\int_1^3 \frac{1}{x}\,dx$ with $n = 4$.

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

$$y'' + 2y' + y = 0 \qquad y(0) = 2 \qquad y'(0) = 4.$$

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

$$y'' + 4y = 0 \qquad y(0) = 1 \qquad y'(0) = 3.$$

18. Solve the initial value second order nonhomogeneous differential equation using the method of undetermined coefficients.

$$y'' + 5y' + 4y = \sin x \qquad y(0) = 0 \qquad y'(0) = 0.$$

19. Tell whether the series converges or diverges and justify your answer by showing reason by a valid test.

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

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

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

(d) $\displaystyle\sum_{n=0}^{\infty} \frac{3}{n^2+1}$

(e) $\displaystyle\sum_{n=0}^{\infty} \frac{n}{3n+1}$

20. Determine the given sum:

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

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

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

(d) $\displaystyle\sum_{n=0}^{\infty} \frac{4}{n!}$

21. Determine the Taylor Series about $x = 0$ for:

(a) $f(x) = \dfrac{1}{1+x}$

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

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

(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 θ 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. $x^2 + y^2 + z^2 = 9$