1. (5 points each) Evaluate the following indefinite and definite integrals.

(a) \( \int x^3 \ln x \, dx \)
(b) \[ \int \frac{x^2 + 3x + 6}{x^3 - 4x} \, dx \]
(c) \[ \int \frac{2}{x^2 \sqrt{4 - x^2}} dx \]

(d) \[ \int_{0}^{\pi/3} \cos^4 x \sin^3 x \, dx \]
(e) \[ \int_{4}^{20} \frac{2}{\sqrt{x - 4}} \, dx \]

2. (5 points each) Consider the curve described by the parametric equations:

\[ \begin{align*}
  x &= t^3 - 4t \\
  y &= t^4 - 4t
\end{align*} \]

(a) Find the points on the curve where the tangent lines are vertical, if any.
(b) Find the arc length of the curve for $-1 \leq t \leq 1$. You may approximate the length numerically.

(c) Find the surface area of the solid of revolution created by revolving the curve around the $x$-axis for $-1 \leq t \leq 1$. You may approximate the area numerically.
3. (6 points) Find the area inside the inner loop of $r = 1 - 2 \sin \theta$.

4. (5 points each) Determine if the following series are absolutely convergent, conditionally convergent, or divergent. You must justify your answers.

(a) $\sum_{k=1}^{\infty} (-1)^{k-1} \frac{k}{k^2 + k + 1}$
(b) $\sum_{k=1}^{\infty} \frac{(-1)^{k+1}(k + 1)3^k}{2^{2k+1}}$

(e) $\sum_{k=2}^{\infty} (-1)^k \frac{3}{1 + \ln k}$
5. (6 points) Find the radius and interval of convergence of the series,

\[ \sum_{k=1}^{\infty} \frac{-3x^k}{2^k \sqrt{k}}. \]
6. (6 points each) Find the exact value of the following limits, if they exist.

(a) \( \lim_{x \to 0^+} (\cos x)^{1/x} \)

(b) \( \lim_{x \to \infty} \left( \sqrt{x^2 + 1} - x \right) \)
7. (6 points) Find a Taylor polynomial of degree 4 for \( f(x) = \ln x \) centered at \( c = 2 \).

8. (5 points) The region in the first quadrant bounded between the curves \( y = e^x - 1 \) and \( y = 2 - x \) is revolved around the \( x \)-axis. Find the volume of the resulting solid of revolution. You may approximate the volume numerically.
9. (5 points) A rocket weighs 9000 lbs at launch and loses 1 lb of fuel for every 15 feet of altitude gained. Find the work done is raising the rocket to an altitude of 12,000 feet.