1. (5 points each) Determine whether the following series converge absolutely, converge conditionally, or diverge. You must justify your answers.

(a) \( \sum_{k=1}^{\infty} (-1)^{k-1} \frac{\sqrt{k}}{k + 1} \)

(b) \( \sum_{k=1}^{\infty} \frac{2}{k^3 + e^k} \)
(c) \[ \sum_{k=1}^{\infty} \frac{k!}{e^k} \]

(d) \[ \sum_{k=1}^{\infty} \frac{(-1)^k}{4k + 7} \]
2. (5 points each) Evaluate the following integrals.

(a) \( \int \sqrt{x} \ln x \, dx \)

(b) \( \int \tan^3 x \sec^3 x \, dx \)
(c) \[ \int \frac{1}{x^2 \sqrt{25 - x^2}} \, dx \]

(d) \[ \int_{-2}^{2} \frac{-1}{(x + 1)^3} \, dx \]
3. (5 points) Find the interval of convergence of the following power series. You must justify your answers.

\[ \sum_{k=0}^{\infty} \frac{k^2}{2^k} (x + 4)^k \]
4. (10 points) Find the area inside one leaf of the rose graphed by $r = \sin 3\theta$. 
5. (6 points) A fish tank has a rectangular base of width 2 ft and a length of 4 ft, and rectangular sides of height 3 ft. If the tank is filled with water weighing 62.4 lb/ft$^3$, find the work required to pump all the water over the top of the tank.
6. (6 points) Use the Maclaurin series for \( \sin x \) to obtain a Maclaurin series for \( f(x) = x \sin 3x \).
7. (6 points) Find the exact value of the arc length of the parametrically defined curve given by

\[ x = 5t^2, \quad y = 2t^3; \quad 0 \leq t \leq 1. \]
8. (3 points each) Suppose that \( f(x) \) is defined as

\[
f(x) = \frac{1}{1 - 3x}; \quad |x| < \frac{1}{3}.
\]

(a) Find a power series representation for \( f(x) \).

(b) Find a power series representation for \( f'(x) \).

(c) Find a power series representation for \( \int_0^x f(t) \, dt \).
9. (6 points) Suppose $R$ is the region bounded by the graphs of the equations

$$y^2 = x \quad \text{and} \quad 2y = x.$$ 

Find the exact volume of the solid of revolution generated if $R$ is revolved around the $y$-axis.

10. (6 points) Find the slope of the tangent line to the graph of the polar coordinate function

$$r = 1 - \sin \theta$$

at $\theta = 0$. 
11. (2 points each) Match the following equations to their type of conic section (parabola, ellipse, or hyperbola).

<table>
<thead>
<tr>
<th>Equation</th>
<th>Conic Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{(x + 1)^2}{4} - \frac{(y - 3)^2}{9} = 1 )</td>
<td>Hyperbola</td>
</tr>
<tr>
<td>( \frac{x + 1}{4} - \frac{(y - 3)^2}{9} = 1 )</td>
<td>Hyperbola</td>
</tr>
<tr>
<td>( \frac{(x + 1)^2}{4} + \frac{(y - 3)^2}{9} = 1 )</td>
<td>Ellipse</td>
</tr>
</tbody>
</table>