Instructions: Show all your work in the space provided under each question. Please write neatly and present your answers in an organized way. Leave values such as π or \( \sqrt{3} \) or \( \sqrt{2} \) as part of your answers.

<table>
<thead>
<tr>
<th>Problem</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points</td>
<td>/12</td>
<td>/12</td>
<td>/6</td>
<td>/10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem</th>
<th>5(a,b)</th>
<th>5(c)</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points</td>
<td>/12</td>
<td>/6</td>
<td>/12</td>
<td>/70</td>
</tr>
</tbody>
</table>

Note: all midterms will have the same weight.
1. Decide whether the given sequence converges or diverges. If it converges, give the limit, and if it diverges, explain briefly why.

(a) \((a_n)_{n=1}^{\infty}\), where \(a_n = \frac{n^2 + n}{4n^2 - n + 1}\)

(b) \((a_n)_{n=1}^{\infty}\), where \(a_n = \frac{1 + (-1)^n}{2}\).
(c) \((a_n)_{n=1}^{\infty}\), where \(a_n = \frac{\sin n}{e^n}\)

2. Decide whether the series converges or diverges. If it converges, evaluate it.

(a) \(\sum_{n=0}^{\infty} \frac{3^{n+1}}{2^{3n}}\)
(2 continued) Decide whether the series converges or diverges. If it converges, evaluate it.

(b) \[ \sum_{n=0}^{\infty} \frac{7^n}{5n+1} \]

(c) \[ \sum_{n=1}^{\infty} \left( \frac{1}{\sqrt{n+1}} - \frac{1}{\sqrt{n+2}} \right) \]
3. Find the center of mass of the region of the plane bounded by the curve $y = 1 - x^2$ and the $x$-axis.
4. (a) Find the Taylor polynomial $T_2$ centered at $a = 1$ for the function $f(x) = \ln x$.

(b) Use your answer to part (a) to approximate $\ln \frac{3}{2}$.

(c) Find an upper bound for the error in the approximation.
5. Determine whether the series converges. Justify your answer.

(a) \( \sum_{n=1}^{\infty} \frac{n^23^n}{n!} \)

(b) \( \sum_{n=1}^{\infty} \frac{2n^3 + n - 1}{n^5 + n^2} \)
\[(c) \sum_{n=1}^{\infty} \left( 1 - \cos \frac{1}{n^2} \right)\]
6. Determine whether the series converges absolutely, converges conditionally, or diverges.

(a) \[ \sum_{n=0}^{\infty} (-1)^n \left( \frac{n^2}{3n^2 + 4} \right)^n \]

(b) \[ \sum_{n=1}^{\infty} (-1)^n \frac{1}{\sqrt{n}} \]