1 (total points: 12). Use the following graph of a given function $f(t)$:

(a) (6 points). Estimate the intervals on which $f'(t) > 0$ and the intervals on which $f'(t) < 0$.

(b) (6 points). Estimate the intervals on which $f''(t) > 0$ and the intervals on which $f''(t) < 0$.

2 (total points: 12 points). Assume that $h(t) = 2^t$.

(a) (7 points). Use average rate of change over the interval $2.99 \leq t \leq 3.01$ to estimate $h'(3)$.

(b) (5 points). Use part (a) to estimate $h(3.1)$.
3 (total points: 14). Differentiate
(a) (4 points). \( f(x) = \sqrt{5} + 5\sqrt{x} + \frac{5}{x} \)

(b) (4 points). \( g(u) = \ln u - e^u + 5(3^u) \)

(c)(6 points). \( y = \frac{x^2}{x + 1} \) (Simplify your answer).

4 (total points: 12).
(a)(4 points). Find the derivative of \( f(x) = (1 + 3x)^{2006} \).

(b) (4 points). Find the derivative of \( f(x) = \ln(1 + x^3) \).

(c) (4 points). Find the derivative of \( f(x) = 5e^{-0.2x} \).
5 (total points: 13). Cost and revenue functions for a company are shown in the following figure.

(a) (7 points). If the current production level is 500 items, should the company produce the 501st item?

(b) (6 points). Estimate the quantity which maximizes profit.

6 (total points: 12). The following table gives the cost and revenue, in dollars, for different production levels, $q$.

<table>
<thead>
<tr>
<th>$q$</th>
<th>0</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R(q)$</td>
<td>0</td>
<td>500</td>
<td>1000</td>
<td>1500</td>
<td>2000</td>
<td>2500</td>
</tr>
<tr>
<td>$C(q)$</td>
<td>700</td>
<td>900</td>
<td>1000</td>
<td>1100</td>
<td>1300</td>
<td>1900</td>
</tr>
</tbody>
</table>

(a) (4 points). At approximately what production level is profit maximized?

(b) (4 points). What price is charged per unit for this product?

(c) (4 points). What are the fixed costs of production?
7 (total points: 12). Find the equation of the tangent line to the graph of \( f(x) = xe^x \) at \( x = \ln 5 \).

8 (total points: 13). The following table shows \( P(t) \), total population (number of people) of a town as a function of \( t \).

<table>
<thead>
<tr>
<th>Year, t</th>
<th>1996</th>
<th>1998</th>
<th>2000</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of people, ( P(t) )</td>
<td>10028</td>
<td>10089</td>
<td>10140</td>
<td>10195</td>
</tr>
</tbody>
</table>

(a) (7 points). Estimate \( P'(2002) \). Give units with your answer and interpret your answer.

(b) (6 points). Use the results of part (a) to estimate \( P(2005) \). Interpret your answer.