Due Friday, April 23 in class

Please do the problems on other paper first, then transfer neat, readable work to this sheet.

Q1: A. A solution region is determined by the constraints below. Graph and shade in the feasible solution region. Indicate on the graph relevant points of intersection.

\[ 3x_1 + x_2 \leq 21 \]
\[ x_1 + x_2 \leq 9 \]
\[ x_1 + 3x_2 \leq 21 \]
\[ x_1, x_2 \geq 0 \]

\[ \frac{3x_1 + x_2 = 21}{(x_1 + x_2 = 9)} \]
\[ 2x_1 = 12 \]
\[ x_1 = 6 \]
\[ x_2 = 3 \]

\[ x_1 + 3x_2 = 21 \]
\[ (x_1 + x_2 = 9) \]
\[ 2x_2 = 12 \]
\[ x_2 = 6 \]
\[ x_1 = 3 \]

B. Find the minimum and maximum values of \( P = 20x_1 + 10x_2 \), if they exist, on the solution region described in A. You must show a table that contains all tested values for credit.

<table>
<thead>
<tr>
<th>((0,0))</th>
<th>(P = 20x_1 + 10x_2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>((0,7))</td>
<td>(P = 0 + 70 = 70)</td>
</tr>
<tr>
<td>((3,6))</td>
<td>(P = 60 + 60 = 120)</td>
</tr>
<tr>
<td>((6,3))</td>
<td>(P = 120 + 30 = 150)</td>
</tr>
<tr>
<td>((7,0))</td>
<td>(P = 140 + 0 = 140)</td>
</tr>
</tbody>
</table>

Maximum = 150 \( @ (6,3) \)

Minimum = 0 \( @ (0,0) \)
You do not need to solve. The setup is all that is needed.

**Q2:** A fast food chain plans to expand by opening several new restaurants. The chain operates two types of restaurants, drive-through and full-service.

- A drive-through restaurant costs $100,000 to construct, requires 5 employees and has an expected revenue of $200,000.
- A full service restaurant costs $150,000 to construct, requires 15 employees, and has an expected annual revenue of $500,000.
- The chain has $2,400,000 in capital available for expansion. Labor contracts require that they hire no more than 210 employees, and licensing restrictions require that they open no more than 20 new restaurants.

How many restaurants of each type should the restaurant open in order to maximize the expected revenue?

A. Define the decision variables and place the data in readable tables.

\[
\begin{align*}
X_1 &= \text{# of drive-through restaurants} \\
X_2 &= \text{# of full-service restaurants} \\
\end{align*}
\]

<table>
<thead>
<tr>
<th></th>
<th>Drive Through</th>
<th>Full Service</th>
<th>Maximums</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Cost</td>
<td>100,000</td>
<td>150,000</td>
<td>2,400,000</td>
</tr>
<tr>
<td>Employees</td>
<td>5</td>
<td>15</td>
<td>210</td>
</tr>
<tr>
<td>Revenue</td>
<td>200,000</td>
<td>500,000</td>
<td></td>
</tr>
</tbody>
</table>

B. Write the constraints that define the feasible solution region. Don't forget the non-negative constraints.

\[
\begin{align*}
X_1 + X_2 &\leq 20 \\
100,000 X_1 + 150,000 X_2 &\leq 2,400,000 \\
5 X_1 + 15 X_2 &\leq 210 \\
X_1, X_2 &\geq 0
\end{align*}
\]

C. What is the objective function?

\[ P = 200,000 X_1 + 500,000 X_2 \]
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x_1 + x_2 &\leq 9 \\
x_1 + 3x_2 &\leq 21 \\
x_1, x_2 &\geq 0
\end{align*}
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C. What is the objective function?