Math 1030 #14c
Linear Modeling
Applications
EX 1: When your first child is born, you purchase a tree to plant. This graph shows the diameter of the tree as a function of time after you planted it.

Input (indep. var.) = \( t = \) time
Output (dep. var.) = diam = \( d \) (cm)

a) How much does the diameter increase each year?
\[ m = \frac{8-2}{4-0} = \frac{6}{4} = \frac{3}{2} \text{ cm/yr} \]

b) When is the diameter 10 cm? \( t = ?, d = 10 \)
\[ 10 = \frac{3}{2}t + 2 \]
\[ 8 = \frac{3}{2}t \Rightarrow t = \frac{16}{3} = 5 \frac{1}{3} \text{ yr} \]

c) What was the diameter when you planted the tree?
\[ d = ? \text{ when } t = 0, \quad d = \frac{3}{2}(0) + 2 = 2 \text{ cm} \]

d) When the child is six, what is the diameter of the tree?
\[ \text{when } t = 6 \text{ yrs, } d = ? \]
\[ d = \frac{3}{2}(6) + 2 = 9 + 2 = 11 \text{ cm} \]

e) Write an equation of this relationship.

(we already did that above)
\[ d = \frac{3}{2}t + 2 \]
EX 2: Your prize-winning ant colony is in a state of emergency. The population is declining at a linear rate and there is nothing you can do about it. You make a table of the population of ants:

\[ n = mt + b \]

<table>
<thead>
<tr>
<th>(indep var) days since start of year</th>
<th>18</th>
<th>34</th>
<th>62</th>
<th>84</th>
</tr>
</thead>
<tbody>
<tr>
<td>(dep var) number of ants</td>
<td>n</td>
<td>9328</td>
<td>8872</td>
<td>8074</td>
</tr>
</tbody>
</table>

a) Find a linear equation that describes your ant colony population as a function of the number of days since the beginning of the year.

1. \[ \text{find } m: \quad (18, 9328) \quad (34, 8872) \]
   \[ m = \frac{9328 - 8872}{18 - 34} = \frac{456}{-16} = -28.5 \text{ ants/day} \]

2. \[ \text{find } b: \quad 9328 = -28.5(18) + b \Rightarrow b = 9841 \text{ ants} \]

3. \[ n = -28.5t + 9841 \]

b) How many ants did you have at your New Year’s party? (day #0)

\[
\text{at day 0, } t = 0, \quad n = \? \quad (\text{this is the } b-\text{value})
\]

\[ n = -28.5(0) + 9841 = 9841 \text{ ants} \]

c) When will the entire ant colony be dead?

\[ t = ? \quad \text{when } n = 0 \]

\[ 0 = -28.5t + 9841 \]

\[ 28.5t = 9841 \]

\[ t \approx 345.3 \text{ by the 346th day} \]

d) The ant colony fair requires a minimum population of 1000. When will your ant colony become ineligible to defend its 1st prize at the fair?

\[ t = ? \quad \text{when } n = 1000 \]

\[ 1000 = -28.5t + 9841 \]

\[ -8841 = -28.5t \]

\[ -28.5 \quad -28.5 \]

\[ t = 310.2 \]

\[ \Rightarrow \text{we'll be ineligible for fair on the 311th day} \]