1. Calculate each of the following.

   a. \[ \begin{bmatrix} 3 \\ 2 \end{bmatrix} + \begin{bmatrix} 4 \\ 1 \end{bmatrix} = \]

   b. \[ \begin{bmatrix} 1 \\ 2 \end{bmatrix} \begin{bmatrix} 4 \\ 1 \end{bmatrix} = \]

   c. \[ \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} \begin{bmatrix} 4 \\ 1 \end{bmatrix} = \]

   d. \[ \begin{bmatrix} 2 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 5 \end{bmatrix}^{-1} = \]

2. Which of the following appears to be a convex or concave (or neither) function of \( x \)?

   a. [Graphs of functions]

   Convex  ________  ________  ________
   Concave  ________  ________  ________
   Neither  ________  ________  ________
b. \( \ln(x) \) on \( x > 0 \). (Show me what you check to draw your conclusions.)

c. \( \exp(x) \) on \( -\infty < x < \infty \). (Show me what you check to draw your conclusions.)

d. \( x^2 + xy + y^2 \) on \( -\infty < x < \infty \) and \( -\infty < y < \infty \). (Show me what you check to draw your conclusions.)

(15) 3. Which of the following is a convex set? (The shaded region is outside the set – the set is in white.)

![Convex set](image.png)

Convex ______

Not Convex ______

Convex ______

Not Convex ______
4. Circle the graph that is most likely to correspond to the following functions. (The axes intersect at the point [0,0].)

a. \( f(x) = 4x^{0.2} \)

b. \( f(x) = -3\exp(-\alpha x) \) where \( \alpha > 0 \). (The axes intersect at the point [0,0].)
5. Indicate whether each of the following problems is (i) a convex program, (ii) a strictly convex program, or (iii) not a convex program. (Indicate what you are checking, and state your conclusions clearly.)

\[
\begin{align*}
\text{minimize} & \quad x^2 + y^2 \\
\text{subject to:} & \quad 5x + 3y \geq 2 \\
& \quad 4x - 2y \leq 5 \\
& \quad x, y \geq 0
\end{align*}
\]

a. 

\[
\begin{align*}
\text{maximize} & \quad x + y \\
\text{subject to:} & \quad x^2 + xy + y^2 \leq 7 \\
& \quad x, y \geq 0
\end{align*}
\]
6. Indicate the signs of the Lagrange multipliers for any locally optimal solution for each of the constraints in each of the problems in question 5.