Let $f : A \to B$. We’ll again use some alternate notation for image and preimage of $f$. For $X \subseteq A$, we define the \textit{image of $X$ under $f$} as the set
\[ f^{-}(X) = \{ f(x) | x \in X \} \subseteq B. \]
For $Y \subseteq B$, we define the \textit{preimage of $Y$ under $f$} as the set
\[ f^{-}(Y) = \{ a \in A | f(a) \in Y \}. \]
Recall that the \textit{power set} of $A$ is the set $P(A) = \{ X | X \subseteq A \}$. Define $f^{-} : P(A) \to P(B)$ by $f^{-}(X)$ is the image of $X$ under $f$. Define $f^{-} : P(B) \to P(A)$ by $f^{-}(Y)$ is the preimage of $Y$ under $f$.

**Problem 1.** Let $f : A \to B$. Determine a necessary and sufficient condition for
(a) $f^{-} : P(A) \to P(B)$ to be injective,
(b) $f^{-} : P(A) \to P(B)$ to be surjective,
(c) $f^{-} : P(B) \to P(A)$ to be injective, and
(d) $f^{-} : P(B) \to P(A)$ to be surjective.

\textit{Hint: There are two ways to approach this problem. One way is you could look at Homework 8 Problems 1 and 2. The second way is you could look at Homework 9 Problems 4 and 5, together with the criteria for left and right invertibility.}

**Problem 2.**
(a) Falkner Section 12 Exercise 16
(b) Falkner Section 12 Exercise 17

**Problem 3.** Falkner Section 12 Exercise 18

**Problem 4.** Falkner Section 13 Exercise 6

**Problem 5.** Falkner Section 13 Exercise 7