Assignment 1 (25%) Consider the following conjectures about weakest preconditions:

- \( \text{wp}(S, T) = T \)
- \( \text{wp}(S, F) = F \)
- \( \text{wp}(S, P) \lor \text{wp}(S, Q) = \text{wp}(S, P \lor Q) \)
- \( \text{wp}(S, P) = \text{wp}(S, Q) \Rightarrow P = Q \)

For all conjectures, \( S \) denotes any program, while \( P \) and \( Q \) denote any predicates.

Are the conjectures true or false? For each true conjecture, explain (informally and in your own words) why it is true. For each false conjecture, explain why it is false and provide a counterexample.
Assignment 2 (25%) Find $P$ and $Q$ such that

$$wp(\text{IF}, x \neq 0) = x \neq y$$  \hspace{1cm} (1)

where IF is defined as:

\[
\text{IF : } \begin{cases} 
\text{if} & P \rightarrow x \leftarrow x - y \\
\text{false} & Q \rightarrow x \leftarrow y
\end{cases}
\fi
\]

Then, prove that your choices of $P$ and $Q$ are correct, ie prove (1).

Assignment 3 (50%) Using the alternative command theorem, show that the following program is correct.

\[
\{ (x = y + 5) \lor (y = x + 6) \} \\
\text{if } y < x \rightarrow x, y := x - 4, y + 7 \\
\text{false} \rightarrow x := y + 3; y := y - 2 \fi \\
\{ (x = y + 5) \lor (y = x + 6) \} 
\]