1. Design a PDA to accept the strings in \((0+1)^*\) such that no prefix has more 1’s than 0’s.  
   01001011001 is a string in this language. Say whether your PDA accepts by final state or empty stack.

2. Design a PDA to accept \(\{a^ib^j\} \mid i=j\) or \(j=k\). Say whether this accepts by final state or empty stack.

3. Design a PDA to accept \(\{0^n1^m \mid n \leq m \leq 2n\}\)

4. Convert the following grammar into a PDA that accepts by empty stack.
   \[ S \Rightarrow 0S1 \mid A \]
   \[ A \Rightarrow 1A0 \mid S \mid \epsilon \]

5. Here is a PDA that accepts strings in \((0+1)^*\) with the same number of 0’s and 1’s. This PDA accepts by empty stack. Chomsky’s algorithm gives a grammar equivalent to this PDA, with grammar symbols of the form \([pXq]\). Give a derivation in this grammar for the string 0101.

\[
\begin{align*}
1,1 & \rightarrow 11 \\
1,0 & \rightarrow \epsilon \\
1,Z_0 & \rightarrow 1Z_0 \\
0,0 & \rightarrow 00 \\
0,1 & \rightarrow \epsilon \\
0,Z_0 & \rightarrow 0Z_0 \\
\end{align*}
\]

\[
\begin{align*}
\epsilon,Z_0 & \rightarrow \epsilon \\
\end{align*}
\]

\[
\begin{array}{c}
P \\
\end{array} \quad \epsilon,Z_0 \quad \rightarrow \quad \begin{array}{c} Q \\
\end{array}
\]