## Assignment 5

1) Which of the following are true?

- PDA is a NFA with a stack.  
- PDA can store infinite amount of information.  
- There exist some languages for which one can construct a CFG but not a PDA.  
- None of the other choices.

**Accepted Answers:**
- PDA is a NFA with a stack.
- PDA can store infinite amount of information.

2) Consider the following grammar,

\[ 5 \rightarrow A | Sb | a | b \]
\[ A \rightarrow aS | Sb \]

Which of the following string are generated by above grammar?

- \(a^5b^5\)
- \(a^5b^5a^5\)
- \(b^5a^5\)
- \(a^5b^5\)

**Accepted Answers:**
- \(a^5b^5\)
- \(a^5b^5\)

3) Let \(A\) and \(B\) be two languages over alphabet \(\Sigma\). Which of the following are true?

- If \(A\) is regular and \(B\) is CFL then \(A \cap B\) is also CFL.  
- If \(A\) is regular and \(B\) is CFL then \(A \cup B\) is also CFL.  
- If \(A\) not CFL and \(B\) is CFL then \(A \cap B\) will not be a CFL.

**Accepted Answers:**
- If \(A\) is regular and \(B\) is CFL then \(A \cap B\) is also CFL.
if A not CFL and B is CFL then A ∪ B will not be a CFL.

**4) What is the language accepted by following PDA?**

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Deterministic Context Free Languages

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Assignment 5 solution

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if A is regular and B is CFL then A ∩ B is also CFL.
if A is regular and B is CFL then A ∪ B is also CFL.

4) What is the language accepted by following PDA?

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

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\[
\begin{align*}
\text{start} \rightarrow q_0 \\
\epsilon, \epsilon & \rightarrow \# \\
\epsilon, \epsilon & \rightarrow \epsilon \\
\epsilon, \# & \rightarrow \epsilon \\
\end{align*}
\]

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\[
 q_0 \rightarrow q_1 \rightarrow q_2 \rightarrow q_3
\]

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\[
\{a^n b^n \mid n \geq 0\}
\]

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\[
\{ww \mid w \in \{a, b\}^*\}
\]

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\[
\{ww' \mid w \in \{a, b\}^*\}
\]

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\[
\{w \mid w \in \{a, b\}^* \text{ is even length palindrome string}\}
\]

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**5) Consider the following languages,**

\[
L_1 = \{ww \mid w \in \{0, 1\}^*\}
\]

\[
L_2 = \{ww' \mid w \in \{0, 1\}^*\}
\]

\[
L_3 = \{w_1w_2 \mid w_1, w_2 \in \{0, 1\}^* \text{ and } w_1 \neq w_2\}
\]

Which of the following is CFL?

- \(L_1\)
- \(L_2\)
- \(L_1 \cup L_3\)
- \(L_1 \cap L_2\)

**Accepted Answers:**

- \(L_2\)
- \(L_1 \cup L_3\)
6) Match the following grammars to the languages they generate

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) ( S \rightarrow SaSaS \mid bS \mid \epsilon )</td>
<td>(a) ( { w \mid w \in {a, b}^*, w \text{ is palindrome} } )</td>
</tr>
<tr>
<td>(2) ( S \rightarrow SaSbS \mid SbSaS \mid \epsilon )</td>
<td>(b) ( { w \mid w \in {a, b}^*, w \text{ contains even number of a's} } )</td>
</tr>
<tr>
<td>(3) ( S \rightarrow aSa \mid bSb \mid aSb \mid bSa \mid \epsilon )</td>
<td>(c) ( { w \mid w \in {a, b}^*, w \text{ is of even length} } )</td>
</tr>
<tr>
<td>(4) ( S \rightarrow aSa \mid bSb \mid a \mid b \mid \epsilon )</td>
<td>(d) ( { w \mid w \in {a, b}^*, w \text{ contains equal number of a's and b's} } )</td>
</tr>
</tbody>
</table>

Accepted Answers:
(1, b) (2, d) (3, c) (4, a)

7) Let \( L \) be a language, we define \( \text{NOPREFIX}(L) \) as,
\( \text{NOPREFIX}(L) = \{ w \mid w \in L \text{ and no proper prefix of } w \text{ is in } L \} \)
Which of the following are true?
- If \( L \) is CFL then \( \text{NOPREFIX}(L) \) is also CFL.
- If \( L \) is CFL then \( \text{NOPREFIX}(L) \) may or may not CFL.
- If \( L \) is regular then \( \text{NOPREFIX}(L) \) is CFL.
- \( \text{NOPREFIX}(L) \) is always CFL irrespective of \( L \).

Accepted Answers:
If \( L \) is CFL then \( \text{NOPREFIX}(L) \) may or may not CFL.
If \( L \) is regular then \( \text{NOPREFIX}(L) \) is CFL.