1. a.

a	b	b XOR a	a XOR (b XOR...
T	T	F	T
T	F	T	F
F	T	T	T
F	F	F	F

b. The function XOR

2.

$$E \to P$$

3.
$$E \to \epsilon$$
$$E \to EP$$
$$E \to TE$$
$$P \to +E$$
$$T \to TM$$
$$T \to (K$$
$$T \to a\epsilon \qquad \text{Terminal}$$
$$M \to xT$$
$$K \to E)$$

4. No, because the string (a) is part of the language, but all possible substrings of (a) can be pumped until the new string not in the language.

$((a)^p \to (a)(a)(a) \qquad (a) \to (((a) \qquad (a^p) \to (aaa,$

$(\ldots)^p \to (a(a(a) \qquad (a)^p \to (a)))$
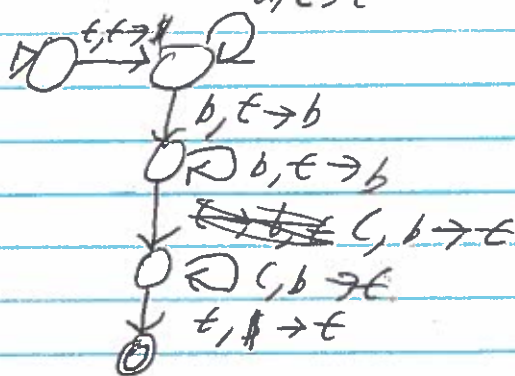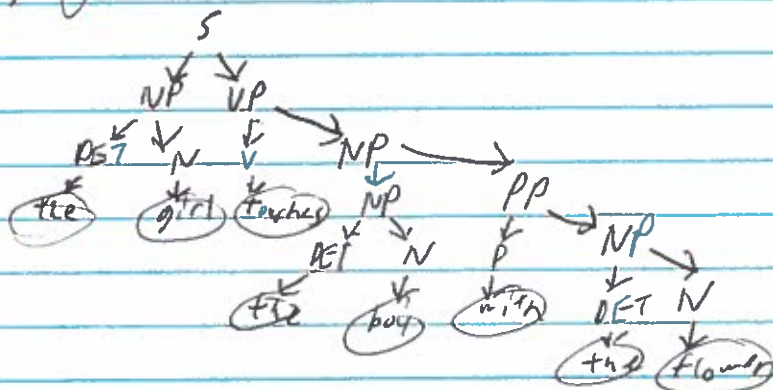
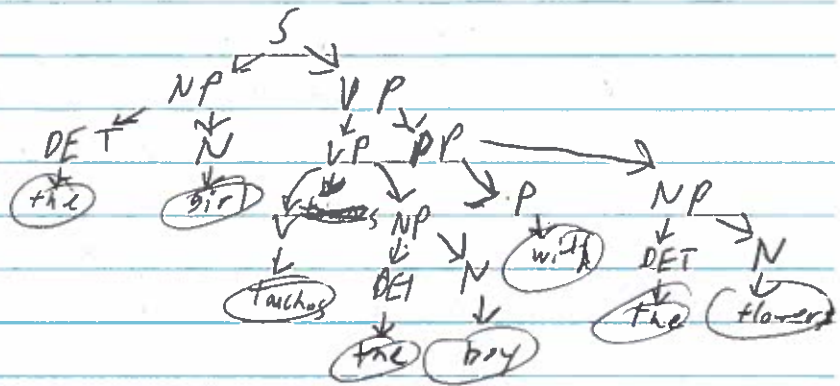5. a. $\{a^i b^i c^j\}$ 　　　　　　　　$\{a^i b^j c^j\}$

Both $\{a^i b^i c^j\}$ and $\{a^i b^j c^j\}$ are context-free languages as they can be written as PDA

$\{a^i b^i c^j\} \wedge \{a^i b^j c^j\} = \{a^n b^n c^n\}$ because the intersection is for $i = j$, and since $\{a^n b^n c^n\}$ is not context-free, context-free languages are not closed under intersection.
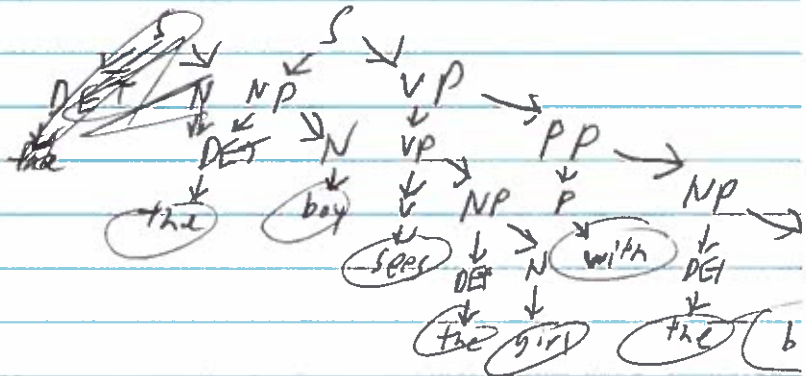
6. a.

$S \rightarrow NP\ VP \rightarrow DET\ N\ VP \rightarrow$ the $N\ VP \rightarrow$ ~~the girl~~
$\rightarrow$ the girl $VP \rightarrow$ the girl $V\ NP \rightarrow$ the girl touches
$\rightarrow$ the girl touches $NP\ PP \rightarrow$ the girl touches $DET\ N\ PP$
$\rightarrow$ the girl touches the $N\ PP \rightarrow$ the girl touches the boy PP
$\rightarrow$ the girl touches the boy $P\ NP \rightarrow$ the girl touches the boy
$\rightarrow$ the girl touches the boy with $DET\ N$
$\rightarrow$ the

[Syntax tree diagram for part (a): S branching into NP and VP. NP → DET (the) + N (girl). VP → VP + PP. VP → V (touches) + NP. NP → DET (the) + N (boy). PP → P (with) + NP. NP → DET (the) + N (flowers).]

b. The sentence can mean that the girl tou_ the boy who has a flower, or the girl uses the flower to touch the boy

c.

[Second syntax tree diagram: S → NP + VP. NP → DET (the) + N. ... DET (the) + N (boy). VP → VP + PP. VP → V (sees) + NP. NP → DET + N. PP → P (with) + NP. with the girl ... the b_]

d. S → NP VP
   NP → NP PP
   NP → DET N
   VP → V NP
   VP → VP PP
   DET → a | the
   N → boy | girl | flowers | binoculars | ADJ N
   ADJ → tall | purple | funny
   V → touches | sees
   PP → P NP
   P → in | from | with

5. b. For the string abc, any choices
   of v and x in uvwxy for
   abc can be pumped such that
   the resulting substring is not in
   the language $\{a^n b^n c^n\}$
   e.g., $a^p b^p c \rightarrow aabb\ c$
   $a^p (bc)^p \rightarrow aa\ k\ bc$