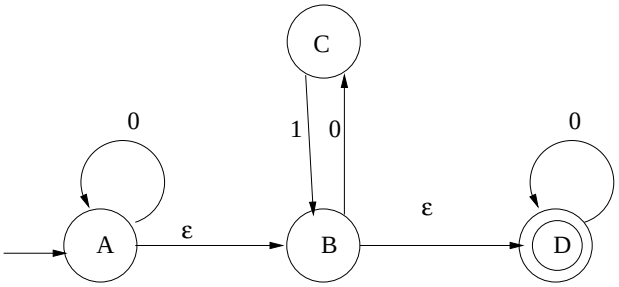
6.035 Practice Quiz 1 **September 29, 2006**

---

1. Give a Regular Expression and DFA for:
   $L = \{x \in \{0,1\}^* \mid x$ ends with 1 and does not contain the substring 00$\}$

2. Give a RE for: $L = \{0^i 1^j \mid i$ is even and j is odd $\}$

3. Given the NFA for below for $0^*(01)^*0^*$, construct a DFA:



4. Give a RE and a DFA/NFA for the language of all strings over $\{0,1\}^*$ that do not end in 01.

5. Give a RE and a CFG for:
   $L = \{x \in \{0,1\}^* \mid x$ starts and ends with different symbols $\}$

6. Give a CFG for:
   $L = \{x \in \{0,1\}^* \mid$ symbol at position i is same as symbol at position i+2 and $\mid x \mid \geq 2\}$

7. Give a CFG for the language of all non-palindromes over $\{0,1\}^*$.

8. Give a CFG for:
   $L = \{0^i 1^j 0^k \mid j > i + k\}$ So, 001111100 is in the string. Hint, the concatenation of two (or more) context-free languages is context-free.

9. Eliminate left recursion from:
   $S \rightarrow Aa \mid b$
   $A \rightarrow Ac \mid Sd \mid \varepsilon$

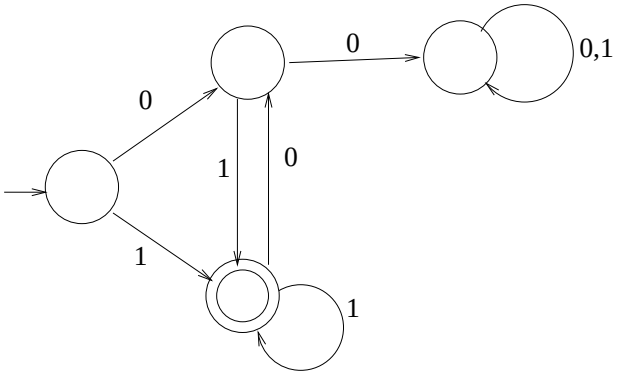
10. Give a CFG for $L = \{a^i b^i c^i \mid i \geq 1\}$.

11. Is this grammar ambiguous? If so, prove it and construct a non-ambiguous grammar that derives the same language.
    $S \rightarrow aS \mid aSbS \mid c$

12. Assume that we have added a pointer type to decaf that can point to integers and booleans. We want to extend our type system (our attributed grammar) to handle these types. We have added a *pointer(t)* type to the type system to denote a pointer of type *t*. Complete the semantic action that propagates the type attribute for a pointer deference expression: $E \rightarrow *E_1$ {: E.type = ???? :}

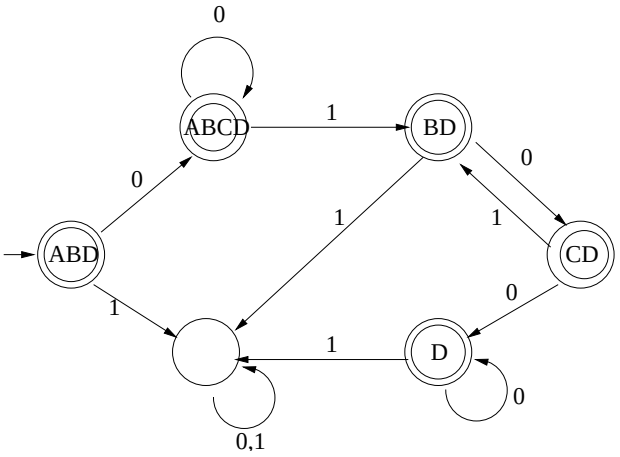
Answers

1. (1 | 01)+

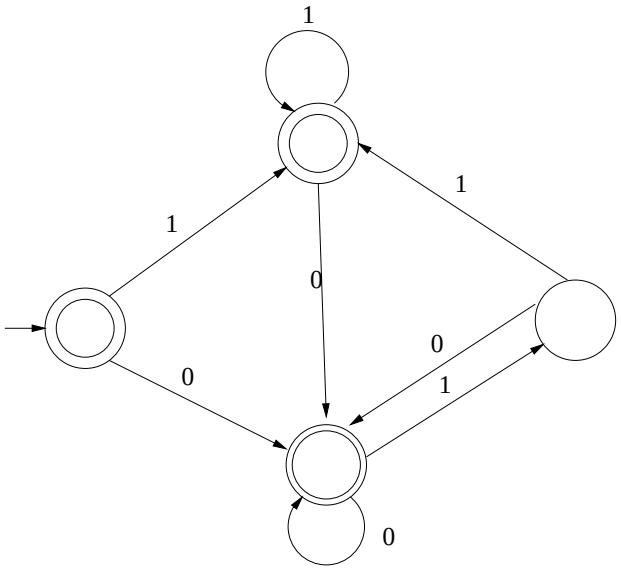


2. (00)*1(11)*

3. DFA:



4. ε | 0 | 1 | (0 | 1)*(11 | 00 | 10)



5. $[a(a \mid b)^*b]|[b(a \mid b)^*a]$
   $S \rightarrow aAb \mid bAa$
   $A \rightarrow aA \mid bA \mid \varepsilon$

6. $S \rightarrow A \mid B \mid C \mid D$
   $A \rightarrow 00A \mid 00$
   $B \rightarrow 11B \mid 11$
   $C \rightarrow 10C \mid 10$
   $D \rightarrow 01D \mid 01$

7. $S \rightarrow 0S0 \mid 1S1|D$
   $D \rightarrow 1A0 \mid 0A1$
   $A \rightarrow \varepsilon \mid 0A \mid 1A$

8. $S \rightarrow ABC$
   $A \rightarrow 0A1 \mid \varepsilon$
   $B \rightarrow 1B \mid 1$
   $C \rightarrow 1C0 \mid \varepsilon$
   L is a concatenation of $L_1L_2L_3$ where $L_1 = \{0^i1^i \mid i \geq 0\}$, $L_2 = \{1^m \mid m > 0\}$, and $L_3 = \{1^k0^k \mid k \geq 0\}$.

9. $S \rightarrow Aa \mid b$
   $A \rightarrow bdA^1 \mid A^1$
   $A^1 \rightarrow cA^1 \mid adA^1|\varepsilon$

10. Trick question, the language is not context-free. Sorry!

11. It is ambiguous! aacbc has two parse trees (not pictured, but you have to show the two parse trees to prove it is ambiguous).

Unambiguous grammar:
$S \rightarrow T \mid U$
$T \rightarrow aTbT \mid c$
$U \rightarrow aS \mid aTbU$

12. $E \rightarrow *E_1$ {E.type := **if** E_1.type = *pointer*(t) **then** t **else** *type_error;*}