

CS341 - Automata Theory (Fall 2001)
Midterm #2 - Solution

1.(a) $S \rightarrow 0S1 \mid 1S0 \mid S01 \mid S10 \mid 01S \mid 10S \mid 1S \mid 1$

1.(b) $S \rightarrow AC \mid B$

$A \rightarrow aAb \mid \epsilon$

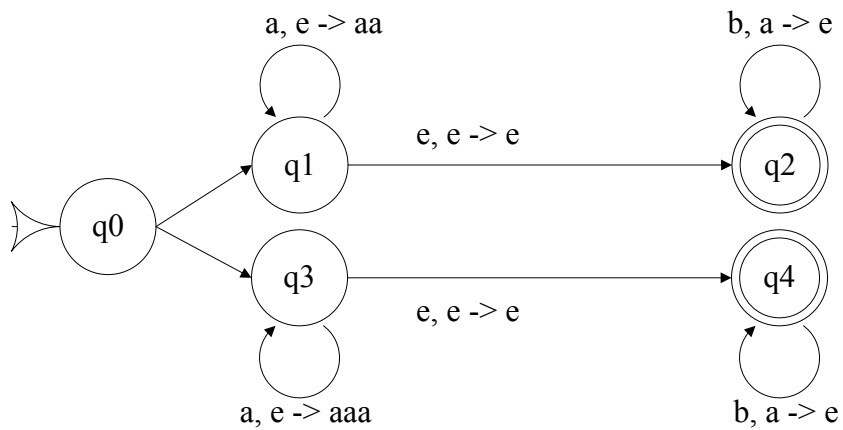
$C \rightarrow cC \mid \epsilon$

$B \rightarrow aB \mid D$

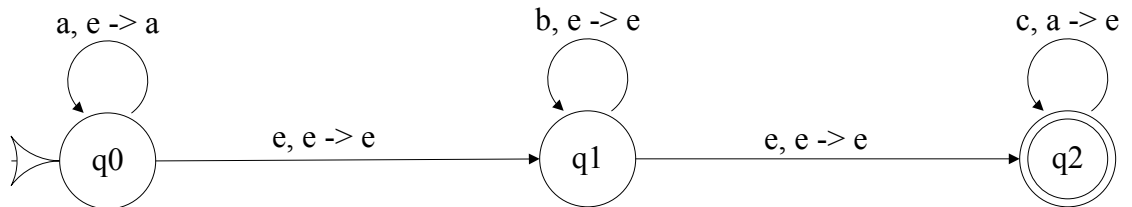
$D \rightarrow bDc \mid \epsilon$

1.(c) $S \rightarrow aSa \mid aSb \mid \epsilon$

2.(a)



2.(b)



3.

Step 1: Add a new start state

$S \rightarrow A$

$A \rightarrow BAB \mid B \mid e$

$B \rightarrow 00 \mid e$

Step 2: Remove e-transitions

a) Remove $B \rightarrow e$

$S \rightarrow A$

$A \rightarrow BAB \mid B \mid e \mid BA \mid AB \mid A$

$B \rightarrow 00$

b) Remove $A \rightarrow e$

$S \rightarrow A \mid e$

$A \rightarrow BAB \mid B \mid BA \mid AB \mid A \mid BB$

$B \rightarrow 00$

Step 3: Remove unit rules

a) Remove $A \rightarrow A$

$S \rightarrow A \mid e$

$A \rightarrow BAB \mid B \mid BA \mid AB \mid BB$

$B \rightarrow 00$

b) Remove $A \rightarrow B$

$S \rightarrow A \mid e$

$A \rightarrow BAB \mid 00 \mid BA \mid AB \mid BB$

$B \rightarrow 00$

c) Remove $S \rightarrow A$

$S \rightarrow BAB \mid 00 \mid BA \mid AB \mid BB \mid e$

$A \rightarrow BAB \mid 00 \mid BA \mid AB \mid BB$

$B \rightarrow 00$

Step 4: Change rules in CNF

$S \rightarrow BX \mid YY \mid BA \mid AB \mid BB \mid e$

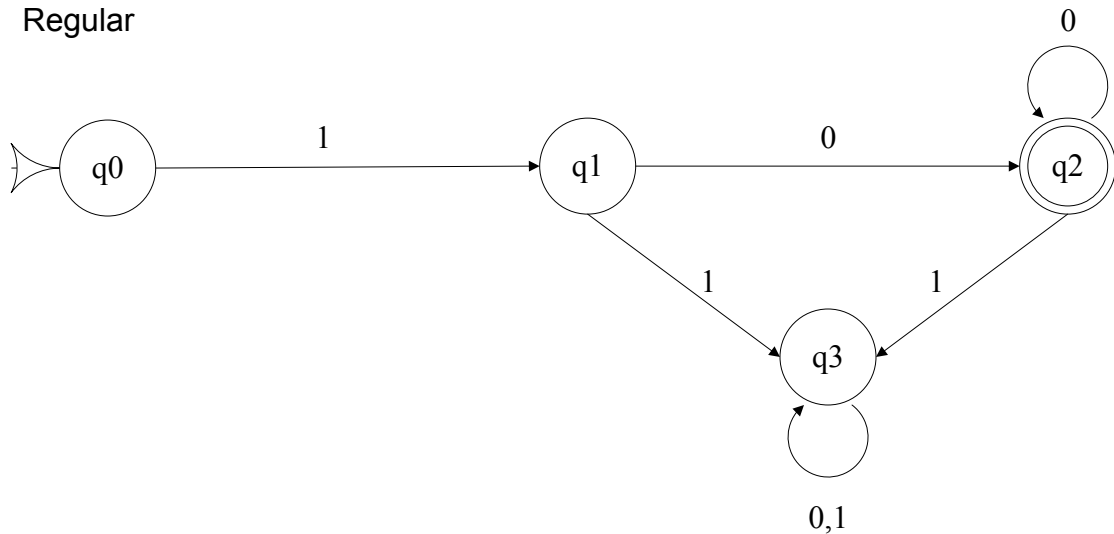
$A \rightarrow BX \mid YY \mid BA \mid AB \mid BB$

$B \rightarrow YY$

$X \rightarrow AB$

$Y \rightarrow 0$

4.(a) Regular



4.(b) Not Context Free

Use string $0^n\#0^{2n}\#0^{3n}$.

Case 1: vxy contains 0's. It will cause one of the sets of 0's to have more or less than what is required.

Case 2: vxy contains 0's from two sets thus the $\#$ is in the x portion. This will cause two of the sets of 0's to have more or less than the required for the third set.

Case 3: v or y contain 0's and the $\#$ symbol. This will break the sequence of only two hash marks in the string. It will introduce more hash marks as you pump up.

4.(c) Not Context Free

Use string $10^n10^n10^n$.

Case 1: vxy contains 0's. It will cause one of the sets of 0's to have more or less than what is required.

Case 2: vxy contains 0's from two sets thus there is a 1 in the x portion. This will cause two of the sets of 0's to have more or less than the required for the third set.

Case 3: v or y contain 0's and a 1. This will break the sequence of only three ones in the string. It will introduce more 1's as you pump up.