1. Convert given CFG to CNF

$S \rightarrow aAS \mid a$

$A \rightarrow SbA \mid SS \mid ba$

$S \rightarrow YAS \mid a$

$A \rightarrow SXA \mid SS \mid XY$

$X \rightarrow b$

$Y \rightarrow a$

$S \rightarrow ZS \mid a$

$A \rightarrow WA \mid SS \mid XY$

$X \rightarrow b$

$Y \rightarrow a$

$Z \rightarrow YA$

$W \rightarrow SX$

2. Convert the given CFG to CNF

$S \to aB$
$S \to bA$
$A \to a$
$A \to aS$
$A \to bAA$
$B \to b$
$B \to bS$
$B \to aBB$

$S \to aB \mid bA$
$A \to @ \mid aS \mid bAA$
$B \to b \mid bS \mid aBB$

$S \to XB \mid YA$
$A \to a \mid XS \mid YAA$
$B \to b \mid YS \mid XBB$
$X \to a$
$Y \to b$

$S \to XB \mid YA$
$A \to a \mid XS \mid YZ$
$B \to b \mid YS \mid XW$
$X \to a$
$Y \to b$
$Z \to AA$
$W \to BB$

3. Convert the given CFG to GNF

$S \to AB$
$A \to BS \mid b$
$B \to SA \mid a$

$S \to A_1$
$A \to A_2$
$B \to A_3$

$A_1 \to A_2 A_3$ $\quad 1 \leq 2$

$A_2 \to A_3 A_1 \mid b$ $\quad 2 \leq 3$

$A_3 \to A_1 A_2 \mid a$ $\quad 3 \not\leq 1$

$A_3 \to [A_2 A_3] A_2 \mid a$

$A_3 \to A_2 A_3 A_2 \mid a$ $\quad 3 \not\leq 3$

$A_3 \to [A_3 A_1 \mid b] A_3 A_2 \mid a$

$A_3 \to A_3 A_1 A_3 A_2 \mid b A_3 A_2 \mid a$ $\quad 3 \leq 3$ ✓

$A_3 \to b A_3 A_2 A_1 A_3 A_2 \mid a A_1 A_3 A_2 \mid b A_3 A_2 \mid a$

$A_2 \to b A_3 A_2 A_1 A_3 A_2 A_1 \mid a A_1 A_3 A_2 A_1 \mid b A_3 A_2 A_1 \mid a A_1 \mid b$

$A_1 \to b A_3 A_2 A_1 A_3 A_2 A_1 A_3 \mid a A_1 A_3 A_2 A_1 A_3 \mid b A_3 A_2 A_3 \mid a A_1 A_3 \mid b A_3$

4. Design PDA for the language L={$a^m b^n c^{2(m+n)}$/ n,m >=1} accepted by empty stack

Logic:

Read a push x

Read b push x

Read c pop every even X

$\delta(q_0, a, z_0) = (q_1, xz_0)$

$\delta(q_1, a, x) = (q_1, xx)$

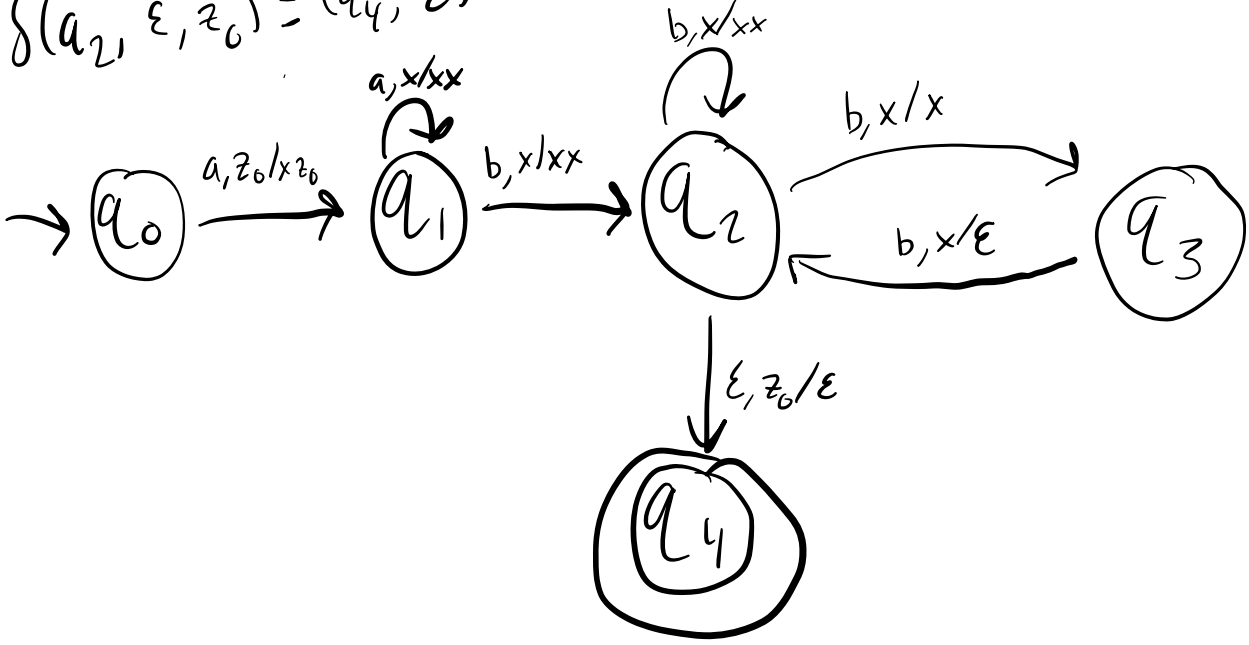
$\delta(q_1, b, x) = (q_2, xx)$

$\delta(q_2, b, x) = (q_2, xx)$

$\delta(q_2, c, x) = (q_3, x)$

$\delta(q_3, c, x) = (q_2, \varepsilon)$

$\delta(q_2, \varepsilon, z_0) = (q_4, \varepsilon)$



5. Construct the PDA for the language $L=\{a^m b^n c^{(m+n)} / n,m >=1\}$ accepted by empty stack

Logic:

Read a, push x

Read b, push x

Read c, pop x

$\delta(q_0, a, z_0) = (q_1, xz_0)$

$\delta(q_1, a, x) = (q_1, xx)$

$\delta(q_1, b, x) = (q_2, xx)$

$\delta(q_2, b, x) = (q_2, xx)$

$\delta(q_2, c, x) = (q_3, \varepsilon)$

$\delta(q_3, c, x) = \delta(q_3, \varepsilon)$

$\delta(q_3, \varepsilon, z_0) = \delta(q_4, \varepsilon)$