(1). Consider a chocolate vending machine that accepts coins of Rs. 1, Rs. 2 and Rs. 5 and dispenses chocolate costing Rs. 12.

(a) Draw a DFA that models this machine.

(b) Define a quintuple for this machine.

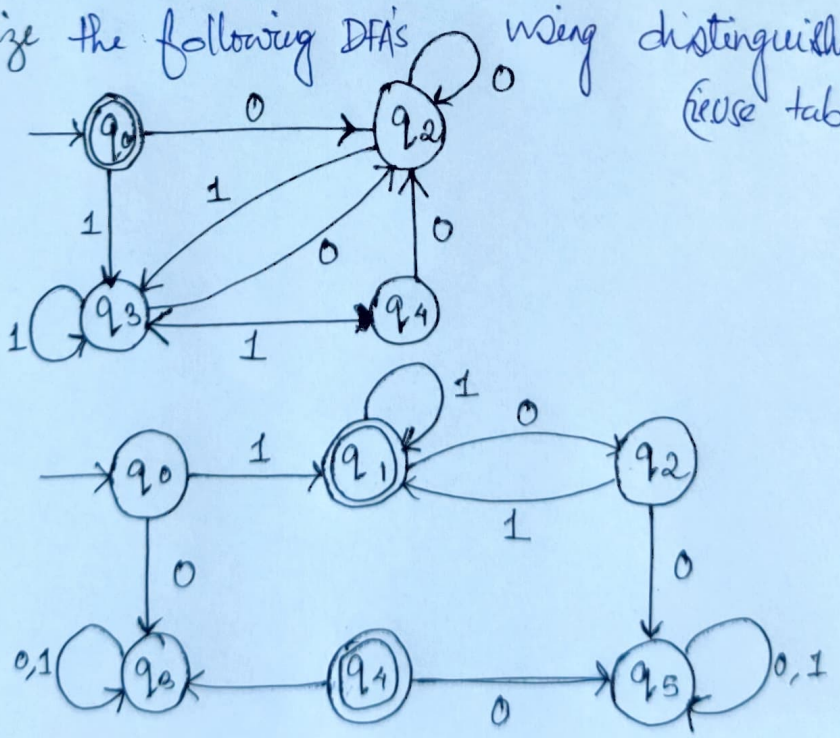
(c) How many states are absolutely required to build this machine?

(2). Let $\Sigma = \{a, b, c\}$. Consider the language consisting of all words that begins and ends with different letters.

Draw a DFA that accepts this language.

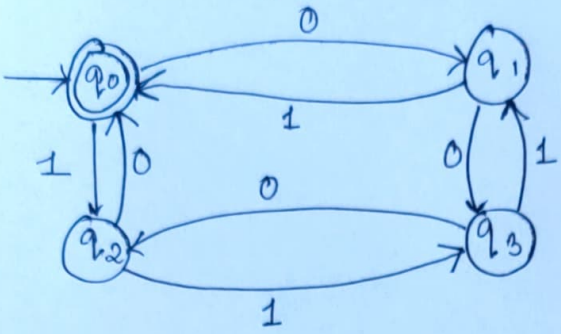
(3). Let $\Sigma = \{a, b, c\}$. Draw a DFA that rejects all words for which last two letters match.

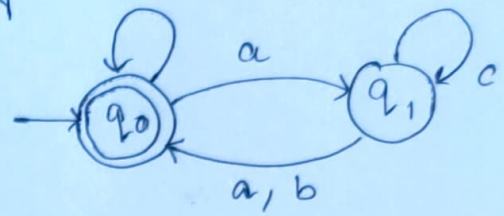
(4). Minimize the following DFA's using distinguishability concept. (reuse tabular method)



(5) (i) Consider the following DFA's.
Convert into Regular Grammar.

(ii) Convert into Regular expressions using recursive formula.





(6) Show a derivation tree for the string aabbbb with the grammar

$S \rightarrow AB \mid \epsilon$

$A \rightarrow aB$

$B \rightarrow Sb$

Give a verbal description of the language generated by the grammar.

(7) Considering grammar

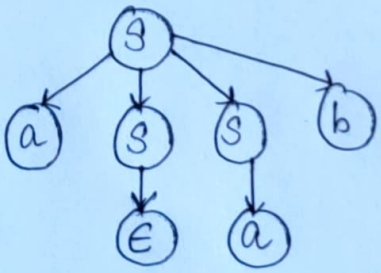
$S \rightarrow aaB$

$A \rightarrow bBb \mid \epsilon$

$B \rightarrow Aa$

Show that the string aabbabba is not in the language generated by this grammar.

(8) Consider the derivation tree below



Find a simple grammar G for which this is the derivation tree of the string aab. Then find two more sentences of L(G).

(9) Show that the following grammars are ambiguous:

(i) $S \rightarrow aSb \mid SS \mid \epsilon$

(ii) $S \rightarrow aSbS \mid bSaS \mid \epsilon$

(10). Show that these two grammars are equivalent:

$S \to abAB \mid ba$
$A \to aaa$
$B \to aA \mid bb$

and

$S \to abAaA \mid abAbb \mid ba$
$A \to aaa$

(11). Simplify the following grammar by removing unit productions, all useless symbols and ϵ-productions from the grammar

$S \to aA \mid aBB$
$A \to aaA \mid \epsilon$
$B \to aB \mid bbC$
$C \to B$

(12). Eliminate useless productions / useless symbols:

$S \to aS \mid AB \qquad A \to bA$
$B \to AA$

- Eliminate unit productions:

$S \to a \mid aA \mid B \mid C$
$A \to aB \mid \epsilon \qquad B \to Aa$
$C \to cCD \qquad D \to ddd$

- Eliminate ϵ-productions:

$S \to AaB \mid aaB \qquad A \to \epsilon$
$B \to bbA \mid a\epsilon$

(13). Convert into CNF:

$S \to abAB$
$A \to bAB \mid \epsilon$
$B \to BAa \mid A \mid \epsilon$

(14). Convert into GNF:

$S \to ABb \mid a$
$A \to aaA \mid B$
$B \to bAb$

(15). A CFG is said to be in two-standard form if all production rules satisfy the following pattern:

$A \to aBC$
$A \to aB$
$A \to a$

where $A, B, C \in V$ and $a \in T$.
Convert the following grammar into two-standard form.

$S \to aSA$
$A \to bABC$
$B \to b$
$C \to aBC$

(16). aab $\in L(G)$? Check using CYK algorithm.

G: $S \to AB$
$A \to BB \mid a$
$B \to AB \mid b$