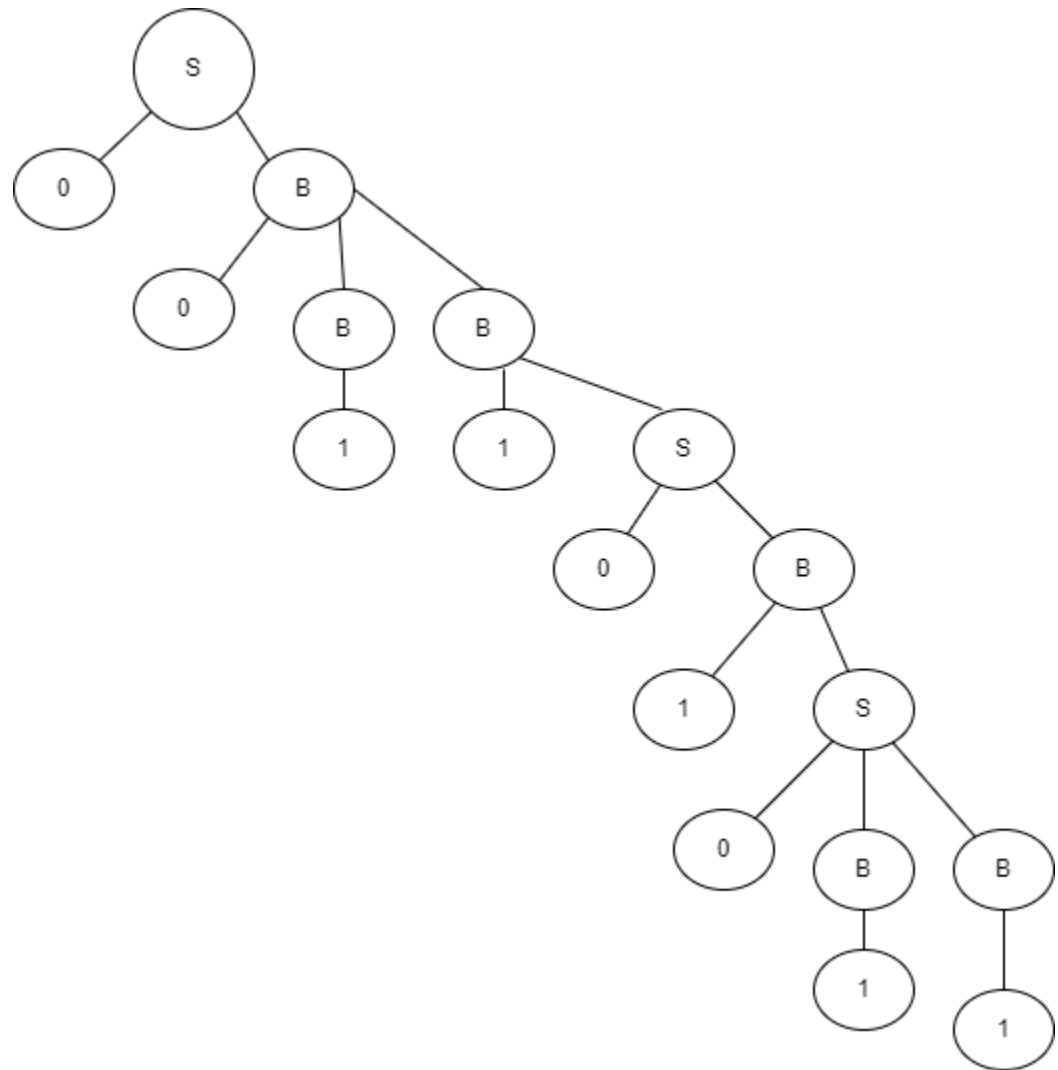
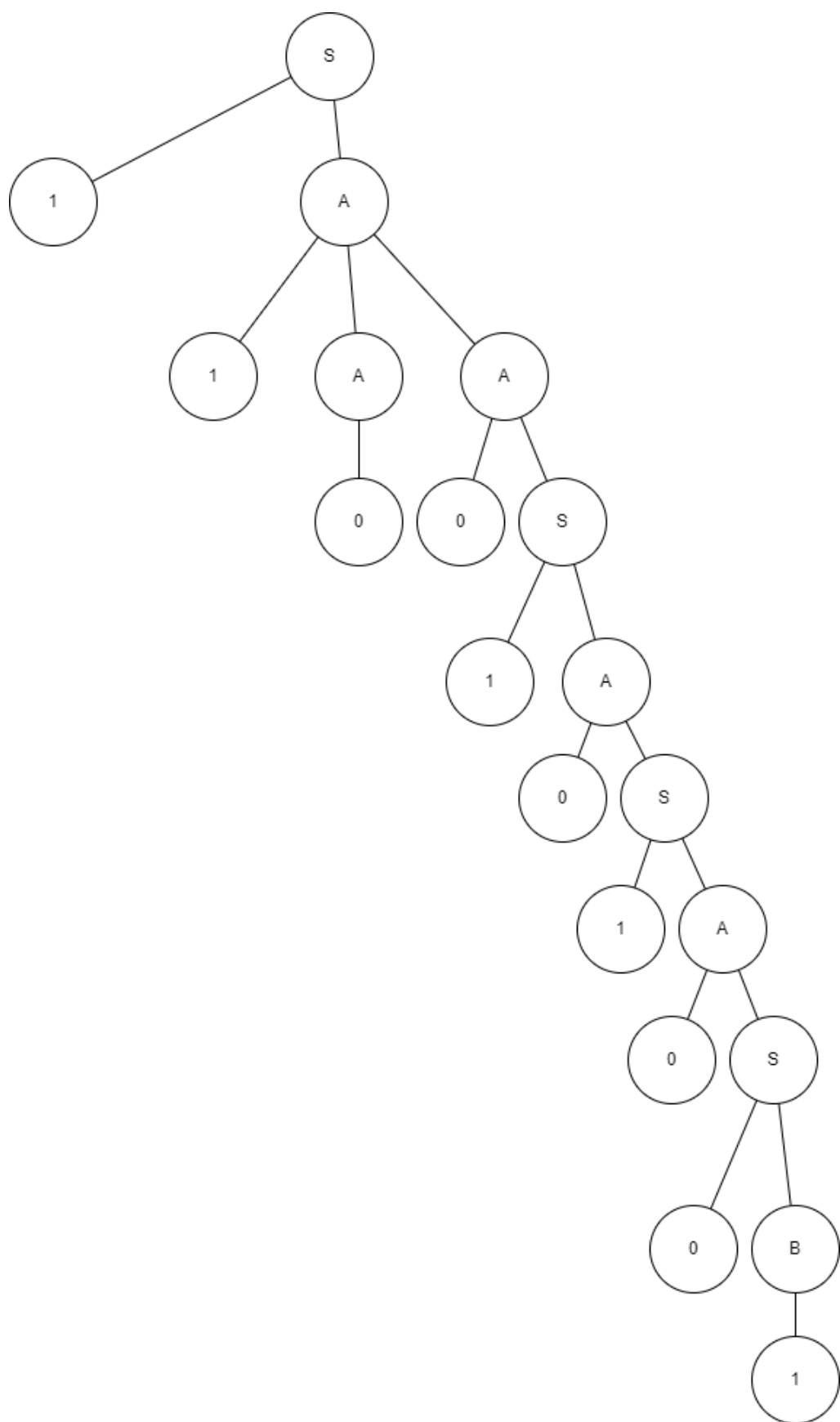


A5

1. Left derivation tree
 - i.



ii.



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3) $P: S \rightarrow ACIB, A \rightarrow a, C \rightarrow c|BC, E \rightarrow aA|e, F \rightarrow bB|e$

Phase I:

$$T = \{a, c, e, b\}$$

$$W_1 = \{A, C, E, F\}$$

$$W_2 = \{A, C, E, F\}$$

$$G' = \{(A, C, E, F), (a, c, e, b), S, P\}$$

$$P: S \rightarrow AC, A \rightarrow a, C \rightarrow c, E \rightarrow aA|e, F \rightarrow e$$

$$Y_1 = \{S\} \quad Y_2 = \{S, A, C\}$$

$$Y_3 = \{S, A, C, a, c\} \quad Y_4 = \{S, A, C, a, c\}$$

$$G'' = \{(A, C, S), (a, c), S, P\}$$

$$P: S \rightarrow AC, A \rightarrow a, C \rightarrow c$$

4) $P: S \rightarrow AB, A \rightarrow a, B \rightarrow Clb, C \rightarrow D, D \rightarrow E, E \rightarrow e$

$B \rightarrow C, C \rightarrow D, D \rightarrow E$

① $D \rightarrow E, E \rightarrow e \Rightarrow D \rightarrow e$

$P: S \rightarrow AB, A \rightarrow a, B \rightarrow Clb, \underline{C \rightarrow D}, D \rightarrow e, E \rightarrow e$

② $C \rightarrow D, D \rightarrow e \Rightarrow C \rightarrow e$

$P: S \rightarrow AB, A \rightarrow a, B \rightarrow \underline{Clb}, C \rightarrow e, D \rightarrow e, E \rightarrow e$

③ $B \rightarrow C, C \rightarrow e \Rightarrow B \rightarrow e$

$P: S \rightarrow AB, A \rightarrow a, B \rightarrow elb, C \rightarrow e, D \rightarrow e, E \rightarrow e$

phase 1

$T = \{a, b, e\}$

$w_1 = \{A, B, C, D, E\}$

$w_2 = \{A, B, C, D, E, S\}$

$w_3 = \{A, B, C, D, E, S\}$

$G' = \{(A, B, C, D, E, S), (a, b, e), S, P\}$

$P: S \rightarrow AB, A \rightarrow a, B \rightarrow elb, C \rightarrow e, D \rightarrow e, E \rightarrow e$

phase 2

$\gamma_1 = \{S\}$

$\gamma_2 = \{S, A, B\}$

$$V_3 = \{S, A, B, a, e, b\}$$

$$V_4 = \{S, A, B, a, e, b\}$$

$$G'' = \{(S, A, B), (a, e, b), S, P\}$$

$$P: S \rightarrow AB, A \rightarrow a, B \rightarrow e|b$$

$$5) S \rightarrow XYXZ, X \rightarrow aX|\epsilon, Y \rightarrow bY|\epsilon, Z \rightarrow c$$

$$X \rightarrow \epsilon, Y \rightarrow \epsilon$$

remove $X \rightarrow \epsilon$

$$S \rightarrow XYXZ \Rightarrow S \rightarrow YXZ | XYZ | YZ$$

$$X \rightarrow aX \Rightarrow X \rightarrow a$$

$$S \rightarrow XYXZ | YXZ | XYZ | YZ$$

$$X \rightarrow aX | a$$

$$Y \rightarrow bY|\epsilon, Z \rightarrow c$$

remove $Y \rightarrow \epsilon$

$$S \rightarrow XYXZ | YXZ | XYZ | YZ$$

$$\Rightarrow XXZ | XZ | Z$$

$$Y \rightarrow bY|\epsilon \Rightarrow Y \rightarrow b$$

$S \rightarrow XYXZ \mid YXZ \mid XYZ \mid YZ \mid XXZ \mid XZ \mid Z$

$X \rightarrow aX \mid a$

$Y \rightarrow bY \mid b$

$Z \rightarrow c$

6)

p: $S \rightarrow ASA11B, A \rightarrow BIS, B \rightarrow 0 \mid \epsilon$

$\xrightarrow{S \rightarrow}$
p: $S' \rightarrow S, ASA11B, A \rightarrow BIS, B \rightarrow 0 \mid \epsilon$

remove $B \rightarrow \epsilon$

$S \rightarrow 1B \Rightarrow S \rightarrow 1$

$A \rightarrow B \Rightarrow A \rightarrow \epsilon$

p: $S' \rightarrow S, S \rightarrow ASA11B \mid 1, A \rightarrow BIS \mid \epsilon, B \rightarrow 0$

remove $A \rightarrow \epsilon$

$S \rightarrow ASA \Rightarrow S \rightarrow AS \mid SA \mid S$

p: $S' \rightarrow S, S \rightarrow ASA11B11 \mid AS \mid SA \mid S, A \rightarrow BIS, B \rightarrow 0$

remove $S' \rightarrow S, S \rightarrow S, A \rightarrow B, A \rightarrow S$

$S \rightarrow ASA11B11 \mid AS \mid SA$

$S' \rightarrow S, A \rightarrow BIS, B \rightarrow 0$

$$S' \rightarrow ASA11B111ASISA$$

$$A \rightarrow B, B \rightarrow 0 \Rightarrow A \rightarrow 0$$

$$A \rightarrow 0 \mid S \Rightarrow A \rightarrow 0 \mid ASA11B111ASISA$$

$$S' \rightarrow ASA, S \rightarrow ASA, A \rightarrow ASA$$

$$X \rightarrow SA$$

$$S' \rightarrow AX11B111ASISA$$

$$S \rightarrow AX11B111ASISA$$

$$A \rightarrow AX11B111ASISA$$

$$B \rightarrow 0$$

$$S' \rightarrow 1B$$

$$S \rightarrow 1B$$

$$A \rightarrow 1B$$

$$Y \rightarrow 1$$

$$X \rightarrow SA$$

$$S' \rightarrow AX1YB111ASISA$$

$$S \rightarrow AX1YB111ASISA$$

$$A \rightarrow AX1YB111ASISA$$

$$B \rightarrow 0$$

CNF

2) a)

$$p: \begin{array}{l} S \rightarrow M1M1M1M \\ M \rightarrow 0M1M1\epsilon \end{array}$$

$$G = \{ (S, M), (0, 1), S, P \}$$

d)

$$p: S \rightarrow 0S01S11S00S110$$

$$G = \{ (S), (0, 1), S, P \}$$

$$c) p: \begin{array}{l} S \rightarrow 0M11M \\ M \rightarrow 00M11M10M01M1\epsilon \end{array}$$

$$G = \{ (S, M), (0, 1), S, P \}$$

$$b) p: \begin{array}{l} S \rightarrow 0M01M11\epsilon \\ M \rightarrow 0M11M1\epsilon \end{array}$$

$$G = \{ (S, M), (0, 1), S, P \}$$