Q.1

Consider the following grammar:

$$S \rightarrow abSba \mid bSb \mid aSa \mid a \mid b \mid \varepsilon$$

What is the language generated by above grammar?

A. CFG that generates all palindromes over alphabet (a, b).

B. CFG that generates all palindromes over alphabet (a, b) that do not contain substring "ab".

C. CFG that generates all palindromes over alphabet (a, b) that contain substring "aa".

D. CFG that generates all palindromes over alphabet (a, b) that do not contain substring "aa".

Q.2

Consider the following grammars: **[MCQ]** (PW)

G_1: $S \rightarrow aSc \mid \$ B$ G_2: $S \rightarrow aaScc \mid \$ B$ G_3: $S \rightarrow aSc \mid \$ B$

    $B \rightarrow bBc \mid \$ \rightarrow b^n \$ c^n$ $B \rightarrow bBc \mid \$ \rightarrow b^n \$ c^n$ $B \rightarrow bbBcc \mid \$$

$b^{2n} \$ c^{2n}$

Which of the following is true regarding G_1, G_2 and G_3?

- **A.** $L(G_1) \subseteq L(G_2)$, $L(G_2) \subseteq L(G_3)$
- **B.** $L(G_2) \subseteq L(G_3)$, $L(G_1) \subseteq L(G_3)$
- **C.** $L(G_1) \subseteq L(G_3)$, $L(G_3) \subseteq L(G_2)$
- **D.** $L(G_2) \subseteq L(G_1)$, $L(G_3) \subseteq L(G_1)$

$$L(G_1) = a^m \$ b^n \$ c^n c^m$$

$$L(G_2) = a^{2m} \$ b^n \$ c^n c^{2m}$$

$$L(G_3) = a^m \$ b^{2n} \$ c^{2n} c^m$$

subset of

Q.3

Consider the following context free grammar:

[McQ] (PW)

$$S \rightarrow aA \mid aBB$$
$$A \rightarrow aaA \mid \in$$
$$B \rightarrow bB \mid bbC$$
$$C \rightarrow B$$

(handwritten annotations):
$S \rightarrow aA \mid \cancel{aBB}$
$A \rightarrow aaA \mid \varepsilon$

$S \rightarrow aA$
$A \rightarrow aaA \mid (\varepsilon) \Rightarrow$
$S \rightarrow aA \mid a$
$A \rightarrow aaA \mid aa$

What will be the equivalent simplified CFG for the given grammar?

A.
$$S \rightarrow aA \mid a$$
$$A \rightarrow aaA \mid aa \mid b$$

B.
$$S \rightarrow aA \mid a$$
$$A \rightarrow aaA \mid aa$$

C.
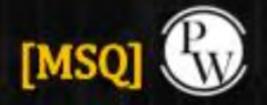$$S \rightarrow aAa \mid B$$
$$A \rightarrow aaA \mid aa$$
$$B \rightarrow bB \mid bb$$

D.
$$S \rightarrow aAa \mid B$$
$$A \rightarrow aA \mid b$$
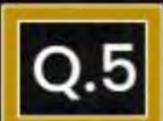$$B \rightarrow bB \mid bb \mid a$$

Q.4 Consider the following grammar:

$$S \to AB$$
$$A \to BaB \mid a$$
$$B \to bbA$$

$\Rightarrow abba$

Which of the following is true regarding given grammar?

A. Every string of the above grammar have at least two a's.

B. Every string have three consecutive a's.

C. Every string have alternate a and b.

D. Every string have b's in multiple of 2.
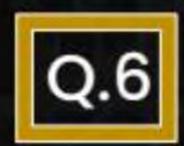
Q.5 Consider the following grammar G: [NAT] (PW)
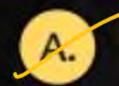
$$S \to XA \mid BB$$
$$B \to b \mid SB$$
$$X \to b$$
$$A \to a$$

After converting above grammar into (GNF) how many productions are there in the grammar?

$= 18$

Handwritten working (yellow, top right):

$$S \to \boxed{X}A \mid \boxed{B}B$$
$$B \to bB' \mid \boxed{X}ABB' \mid b \mid \boxed{X}AB$$
$$B' \to \boxed{B}BB' \mid \boxed{B}B$$
$$X \to \boxed{b}$$
$$A \to \boxed{a}$$

Handwritten working (yellow, lower left):

$$B \to b \mid \textcircled{S}B$$
$$\Downarrow$$
$$B \to b \mid XAB \mid \boxed{B}B\,B$$
$$\Downarrow$$
$$\boxed{B \to bB' \mid X\partial BB' \mid b \mid XAB}$$
$$B' \to BBB' \mid BB$$
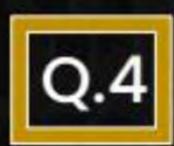
Handwritten working (green, right):

5   $S \to bA \mid bB'B \mid b\partial BB'B \mid bB \mid b\partial BB$

4   $B \to bB' \mid bABB' \mid b \mid b\partial B$

8   $B' \to bB'BB' \mid b\partial BB'BB' \mid bBB' \mid b\partial BBB'$
$\mid bB'B \mid b\partial BB'B \mid bB \mid b\partial BB$

$A \to a$

Q.6 Which of the following is true ? [MSQ]

A. A grammar is called ambiguous if
(No. of parse tree's = No. of left most derivation = Number of Right most derivation) > 1
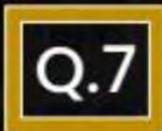
B. Production of the form $A \rightarrow a$ is known as unit production.

C. CNF is also known as binary standard form.

D. In left-most derivation, right most non-terminal is substituted with its production to derive a string.
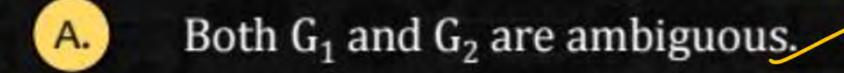
Given the following two grammars:

G_1: S → AB | aaB

  A → a | Aa

  B → b
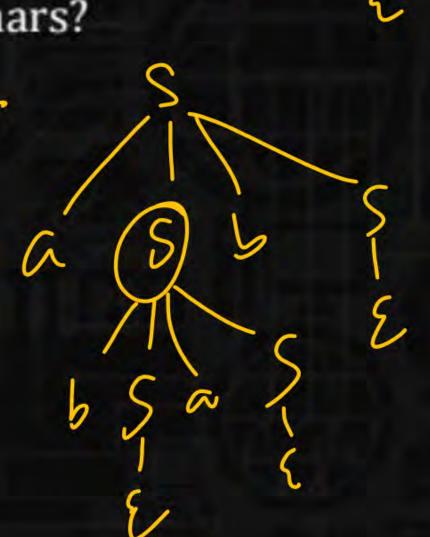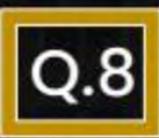
G_2: S → aSbS | bSaS | ∈

What is true regarding above grammars?

A. Both G_1 and G_2 are ambiguous.

B. Both G_1 and G_2 are unambiguous.

C. Only G_1 is ambiguous.

D. Only G_1 is unambiguous.

Q.8

Consider the following languages

[MCQ]

$L_1 = \{a^n b^{n+m} c^m \mid n, m \geq 0\}$ = $a^n b^n b^m c^m$ → non reg

$L_2 = \{a^p b^q c^{p+q} \mid p, q \geq 0\}$ = $a^p b^q c^q c^p$

Which of the following is true?

A. Only L_1 is Regular.

B. Only L_2 is Regular.

C. Both L_1 and L_2 are Regular.

D. None of these