

CS & IT ENGINEERING

Theory of Computation
Push Down Automata

CFL (Closure properties)
DPP 05 (Discussion Notes)



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A stylized illustration of a laptop with a blue frame and an orange base. The screen is white and displays the text 'TOPICS TO BE COVERED'.

TOPICS TO BE COVERED

A dashed orange line with arrowheads at the end, connecting the laptop screen to the list items.

01 Question

02 Discussion

Q.1

The intersection of CFL and a regular language will be

[MCQ]



A.

Always regular

B.

Always CFL

C.

Always not regular

D.

None of these

$CFL \cap Reg \Rightarrow CFL$
(may or may not reg)

Q.2

Consider the following grammars G_1 , G_2 and G_3 : $G_1: S \rightarrow P Q$ $P \rightarrow 0 P 1 | \epsilon$ $Q \rightarrow 1 Q 2 | \epsilon$ $G_2: S \rightarrow 0 S 1 | Q$ $P \rightarrow 1 Q 2 | \epsilon$ $G_3: S \rightarrow P Q | Q$ $P \rightarrow 0 P 1 | 01$ $Q \rightarrow 1 Q 2 | \epsilon$

Here, $\{S, P, Q\}$ are variables where S is start symbol. $\{0, 1, 2\}$ are terminals.

Which of the following is true?

A. G_1 and G_2 are equivalent.B. G_1 and G_3 are equivalent.C. G_2 and G_3 are equivalent.

D. None of these.

 $G_1: S \rightarrow P Q$ $P \rightarrow 0 P 1 | \epsilon$ $Q \rightarrow 1 Q 2 | \epsilon$ $G_2: S \rightarrow 0 S 1 | Q$ $P \rightarrow 1 Q 2 | \epsilon$ $G_3: S \rightarrow P Q | Q$ $P \rightarrow 0 P 1 | 01$ $Q \rightarrow 1 Q 2 | \epsilon$

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D. None of these.

Q.3

Consider the following regular expressions P, Q and R over $\Sigma = \{a, b\}$: 

$$P = ab + aQ + bR$$

$$Q = baQ + bR$$

$$R = Raba + a$$

[MSQ]

$$R \rightarrow Raba + a$$

Which of the following regular expression will produce all the strings accepted by above regular expression?

$$x^*y^* = x^+y^+$$

$$x^+y^+ = x^*y^*$$

~~A.~~

$$ab + ba(aba)^* [\epsilon + a(ba)^*]$$

B.

$$ab + [\epsilon + a(ba)^*] ba(aba)^*$$

C.

$$ab + a(ba)^* ba(aba)^*$$

D.

$$ab + a(ba)^* (aba)^* + ba(aba)^*$$

$$R = a(aba)^*$$

$$Q = (ba)^* ba(aba)^*$$

$$P = ab + a(ba)^* ba(aba)^* + ba(aba)^*$$

Q.4

Consider the following languages

L_1 = Context free language.

L_2 = Deterministic context free language.

L_3 = Context sensitive language.

L_4 = Regular

Which of the following is incorrect?

A. $L_2 \cdot L_4$ is always DCFL. \rightarrow TRUE

B. $L_1 \cap L_3$ is CSL.

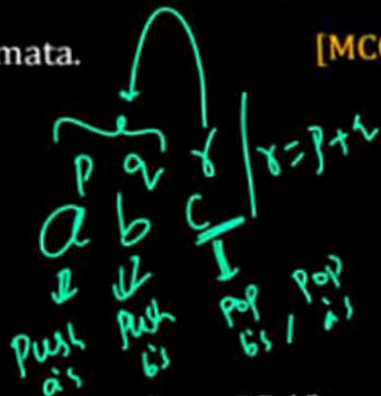
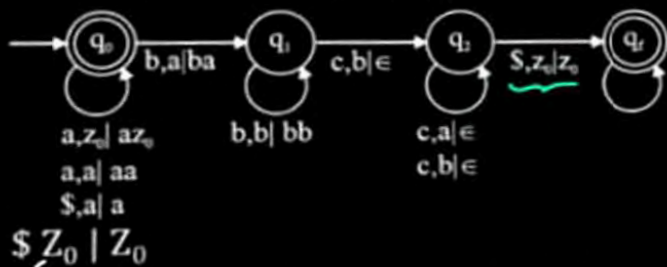
C. $\Sigma^* - L_3$ is CSL.

~~D.~~ None of the above.

Q.5

Consider the following push down automata.

[MCQ]

PDA = $\{Q, \Sigma, \delta, \Gamma, q_0, Z_0, q_f\}$ 

\$ is end of ip

Which of the following language is accepted by above PDA?

A.

 $L = \{a^*\} \cup \{a^p b^q c^r \mid p, q, r \geq 1, p + q = r\}$

B.

 $L = \{a^{p+q} b^{q+r} \mid p, q, r \geq 0\}$

C.

 $L = \{a^p b^q c^r \mid p, q, r \geq 1\}$

D.

None of these.

 $q_0: a^*$

Q.6

Consider the following language:

$$L_1 = \{ab^n a^{2n} \mid n \geq 1\}$$

$$L_2 = \{aab^n a^{3n} \mid n \geq 1\}$$

Which of the following is correct?

[MSQ]

A.

 $L_1 \cup L_2$ is DCFL but not regular.

B.

 $L_1 \cup L_2$ is CFL but not DCFL.

C.

 $L_1 \cup L_2$ is CSL but not CFL.

D.

 $L_1 \cup L_2$ is DCFL and also CFL.

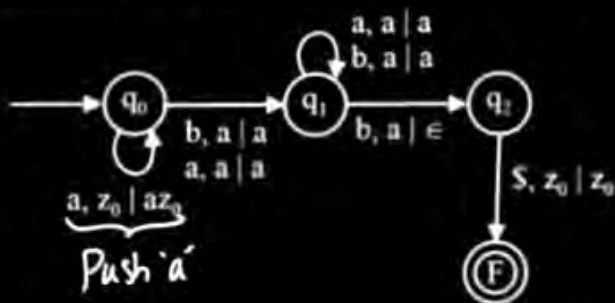
$$L_1 \cup L_2 = \{ab^n a^{2n} \mid n \geq 1\} \cup \{aab^n a^{3n} \mid n \geq 1\}$$


$$\begin{matrix} ab \dots \\ aa \dots \end{matrix}$$

Q.7

Consider the following PDA:

[MCQ]



Handwritten analysis of the PDA's operation:

The input string is $a(b+a)(a+b)^*b\$$, where $\$$ is the end marker. The PDA processes the string by pushing 'a' onto the stack when it reads 'b' in the first part. When it reaches the end marker $\$$, it pops the stack. The handwritten note "skip" is under the $(a+b)^*$ part, indicating that the PDA skips this part of the string. The final state reached is q_2 , which is the final state.

Here q_0 is a starting state and F is a final state. Then the language accepted by above PDA is?

A.

Regular but finite

B.

Regular but infinite

C.

CFL but not regular

D.

None of these

Handwritten language expression: $a(a+b)^+b$

Q.8

Suppose, L is any CFL language on alphabet $\Sigma = \{a, b\}$, and the following language:

[MSQ]

$$L_1 = L - \{w x w^R \mid w, x \in \{a, b\}^*\}$$

$$L_1 = L - (a+b)^* = \phi$$

$$L_2 = L_1 \cdot L$$

$$L_2 = L_1 \cdot L = \phi \cdot L = \phi$$

$$L_3 = \bar{L} \cup L = \Sigma^*$$

$$L_3 = \Sigma^*$$

Which of the following is/are correct?

☒ A.

L_1 is finite.

☒ B.

L_2 is CFL.

☒ C.

L_3 is regular.

☐ D.

None of these.

