Branch : CSE & IT **Batch: Hinglish**

WEEKLY TEST – 04

Subject : Theory of Computation

Finite Automata

Maximum Marks 15

Q.1 to 5 Carry ONE Mark Each

1. [MSQ]

Consider the following language:

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

$L_2 = \{a^n c^n \mid n \geq o\}$

Which of the following is/are correct.

(a) L_1 & L_2 are both DCFL.

(b) $L_2 – L_1$ is regular but not finite.

(c) $L_1 . L_2$ is CFL.

(d) $L_1 . L_2^R = \{a^n b^m c^{n+q} a^q \mid m, n, q \geq 0\}$

2. [MSQ]

Which of the following statement is/are correct?

(a) The intersection of CSL with complement of regular language may be a CFL.

(b) The intersection of regular language with complement of CFL may be regular.

(c) The complement of RE is Not RE.

(d) The complement of Not RE is Not RE.

3. [NAT]

The number of wrong statement from the following:

(i) Superset of CFL can be regular.

(ii) Regular language can also have represented using non- regular grammar.

(iii) NPDA is more powerful than DPDA.

(iv) If L_1 & L_2 are context free languages then $L_1 \cap \overline{L_2}$ is context free language.

(v) The intersection of CFL with infinite language need not to be CFL.____

4. [MSQ]

Which of the following is/are undecidable?

(a) Given CFG is ambiguous or not.

(b) Given grammar is CFG or not

(c) For CFG G, L(G) contains a palindrome

(d) For two CFG G_1 & G_2, $L(G_1) \cap L(G_2) = \phi$

5. [MCQ]

Consider the following statements:

S_1: It is undecidable whether L(G) is regular for CFG G.

S_2: It is undecidable whether L(G) = regular for context free grammar G.

Choose the correct statement from the following.

(a) S_1 is true, S_2 is false

(b) S_1 is false, S_2 is true

(c) Both S_1 and S_2 are true.

(d) Both S_1 and S_2 is are false

Q.6 to 10 Carry TWO Mark Each

[MCQ]

6. Consider two languages L_1 and L_2. L_1 is regular and L_2 is deterministic context free language.

$$L = \overline{L_1} \cup \left(\overline{L_1} \cap \overline{L_2}\right) \cup L_2$$

Then the language L will be

(a) DCFL (b) CFL
(c) Regular (d) None of these

[MCQ]

7. A context free grammar without any useless symbol is known as ____.

(a) Simplified CFG.
(b) Non-redundant CFG
(c) Inherent CFG
(d) None of these

[MCQ]

8. Which of the following is reduced CFG for the below grammar:

G: $S \rightarrow AB \mid cd$
$A \rightarrow Bb \mid a \mid \in$
$B \rightarrow abBC \mid bb \mid \in$
$C \rightarrow aA \mid cD \mid c$
$D \rightarrow bB \mid dD \mid d$

(a) $S \rightarrow aBb \mid cd$
$A \rightarrow Bbb \mid a$
$B \rightarrow bb \mid abBc$
$C \rightarrow aA \mid cD \mid c$
$D \rightarrow bB \mid dD \mid d$

(b) $S \rightarrow AB \mid cd$
$A \rightarrow Bb \mid a \mid \in$
$B \rightarrow abBc \mid bb \mid \in$

(c) $S \rightarrow cd \mid abb \mid Bbbb \mid \in$
$A \rightarrow bbb \mid a \mid abbbc \mid abcb$
$B \rightarrow abc \mid abbbc \mid ababbbcc$
$C \rightarrow aa \mid cd \mid c$

(d) None of these

[NAT]

9. Consider the following statements

(i) Subsequence of regular language is regular.
(ii) Regular languages is closed under substitution.
(iii) Superset of regular language is regular.
(iv) Subset of regular language is regular.

How many of the above statements are true?______.

[MCQ]

10. Consider the following context free grammar:

$S \rightarrow 0S0 \mid 1S1 \mid 1 \mid 0 \mid \in$

For the above CFG, the total number of odd length strings generated whose length is less than or equal to 0 is ____.

(a) 8 (b) 29
(c) 14 (d) 22

Answer Key

1. **(a, c, d)**
2. **(a, b)**
3. **(1)**
4. **(a, c, d)**
5. **(c)**
6. **(b)**
7. **(b)**
8. **(b)**
9. **(2)**
10. **(c)**

Hints and Solutions

1. (a, c, d)

Sol. (A) $L_1 = \{a^n b^m c^n \mid m,n \geq 0\}$ is DCFL

$L_2 = \{a^n c^n \mid n \geq 0\}$ is also DCFL

So, option A is correct.

(B) $L_2 - L_1 = L_2 \cap \overline{L_1}$

$L_2 - L_1 = L_2 - (L_1 \cap L_2)$

$= L_2 - (a^n c^n)$

$= \phi$

ϕ is regular and finite. So, option B is incorrect.

(C) $L_1 \cdot L_2$ = DCFL· DCFL [DCFL ar closed under

= DCFL concatenation]

$\therefore$ DCFL is subset of CFL

So, $L_1 \cdot L_2$ is CFL, Hence option C is correct.

(D) $L_1 . L_2^R = \{a^n b^m c^{n+q} \mid m, n, q \geq 0\}$

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

$L_2 = \{a^n c^n \mid n \geq 0\}$

$L_1 . L_2^R = \{a^n b^m c^n c^q a^q\}$

$= \{a^n b^m c^{n+q} a^q\}$

So, D is also correct.

2. (a, b)

Sol. (A) CSL $\cap$ $\overline{\text{Reg}}$ = CSL $\cap$ Reg = CSL

$\because$ CFL $\subseteq$ CSL

So, the language may be a CFL. Correct

(B) Reg $\cap$ $\overline{\text{CFL}}$ = Reg $\cap$ CSL = CSL

$\because$ Reg $\subseteq$ CFL $\subseteq$ CSL

So, the language may be regular correct.

(C) RE not closed under complement. So it may be RE and may not be RE. Incorrect

(D) Not RE are not closed under any operation so, Incorrect.

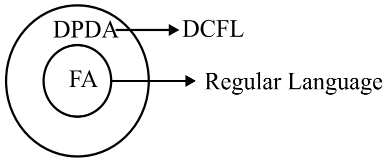
3. (1)

Sol. (i) Superset of CFL can be regular.

$(a+b)^*$ $\supset$ $(a^n b^n)$

↑ ↑

Regular CFL



(ii) Eevery regular language is DCFL also. So every regular langauge can be generated by DPDA or PDA or LBA or TM.

(iii) NPDA $\supseteq$ DPDA So, True.

(iv) L_1 & L_2 are CFL. CFL are not closed under complementation and intersection. So this statement is false.

(v) CFL $\cap$ infinite = Need not to be CFL, need not to be finite.

So, correct statement.

4. (a, c, d)

Sol. (a) Given CFG is ambiguous or not. It is undecidable

(b) Given grammar is CFG or not. It is deciable

(c) For CFG G, L(G) contains a palindrome. It is undecidable

(d) For two CFG G_1 & G_2, $L(G_1) \cap L(G_2) = \phi$. It is undecidable

5. (c)

Sol. S_1:

Start with a fixed nonregular context-free language $L_0 \subseteq \Sigma^*$ Let # be a symbol not in Σ. Now for given G consider $L_1 = L_0 \# \Sigma^* \cup \Sigma^* \# L(G)$. L_1 is context-free. We argue that L_1 is regular iff $L(G) = \Sigma^*$. Assume we find a string $w \notin L(G)$ then $L_1 \cap (\Sigma^* \# w) = L_0 \# w$. As L_0 is nonregular, also $L_0 \# w$ is nonregular. Context-free languages are closed under intersection with regular languages so L1 cannot be regular. On the other hand, when $L(G) = \Sigma^*$ then $L_1 = \Sigma^*\#\Sigma^*$, which is regular. So deciding regularity of L1 would be equivalent to deciding whether $L(G) = \Sigma^*$, which is impossible.

S_2: it is undecidable

So, option C is correct.

6. (b)

$$L = \overline{L_1} \cup \left(\overline{L_1} \cap \overline{L_2}\right) \cup L_2$$

$$L = \overline{Reg} \cup \left(\overline{Reg} \cap \overline{DCFL}\right) \cup DCFL$$

$$= Reg \cup (Reg \cap DCFL) \cup DCFL$$

$$= Reg \cup DCFL \cup DCFL$$

$$= Reg \cup CFL$$

$$= CFL$$

7. (b)

A context-free grammar without any useless symbol is known as reduced context-free grammar or non-redundant CFG.

Therefore, option (b) is correct.

8. (b)

Reduced CFG means removal of all useless symbols from CFG.

After removing all useless symbols from above grammar it will become

$S \to AB \mid cd$

$A \to Bb \mid a \mid \in$

$B \to abBC \mid bb \mid \in$

$\therefore$ option (b) is correct.

9. (2)

Regular language are closed under subsequence, substitution.

Whereas regular language are not closed under superset and subset.

Therefore, (i), (ii) are true.

10. (c)

Odd-length strings:

Number of 1-length string = 2

Number of 3-length string = 4

Number of 5-length string = 8

Total string = 2 + 4 + 8 = 14

$\therefore$ option (c) is correct.