CS & IT ENGINEERING

Theory of Computation

Lecture No.- 06

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Recap of Previous Lecture

- **Topic** Regular Languages
- **Topic** Context Free Grammars
- **Topic**
- **Topic**
- **Topic**

Topics to be Covered

Topic Regular Languages

Topic Context Free Languages

Regulars and CFGs : NAT

Q70. If $L = \{b^n a^n \mid n \geq 0\}$, then how many following statements are TRUE?

= 1

I. L^* is a regular language

II. Reversal of L is a regular language

III. Complement of L is a regular language $\overline{\{b^n a^n\}}$

IV. Finite Subset of L is always regular language

$$L = b^n a^n$$

$$\bar{L} = \Sigma^* - L$$

$$= (a+b)^* - \{b^n a^n\}$$

$$= \boxed{\Sigma^* ab \Sigma^* \cup \{b^m a^n \mid m \neq n\}}$$ is not reg

$$L \cup \bar{L} = (a+b)^*$$

Regulars and CFGs : MCQ

Q71. How many of the following statements are correct?.

I. Every regular language is finite language
II. Every finite language is regular language
III. Every CFL is regular language
IV. Every regular language is CFL

A. 4

B. 3

C. 2

D. 1

Regular Languages : NAT

Q72. How many of the following languages are $\boxed{\text{regular?}}$

$= axa + bxb$

$= a(a+b)^+a + b(a+b)^+b$

- $L_1 = \{\boxed{wxw^R} \mid w, x \in \{a, b\}^+$, w^R is the reverse of string $w\}$
- $L_2 = \{w \mid w, x \in \{a, b\}^*$, number of 01's in w is even$\}$
- $L_3 = \{w \mid w, x \in \{0, 1\}^*$, Dec(w) is divisible by 100$\}$
- $L_4 = \{w \mid w, x \in \{a, b\}^*$, w has more 0's than 1's$\}$

$n_0(w) > n_1(w)$

$= 3$

Regulars and CFGs : MSQ

Q73. Choose FALSE statement.

A Substitution is closed for regular languages T

B Substring is closed for regular languages T

C Subset is closed for regular languages F

D Finite subset is closed for regular languages T

Q74. Let L = { w1w2w3 | w1, w2, w3 ∈ { a, b }*, |w1| = |w2|= |w3| }. Choose L from the following.

L = { w | |w| is div by 3 }

w_1	w_2	w_3		
0	0	0	→	0
1	1	1	→	3
2	2	2	→	6
3	3	3	→	9
				⋮

A (a+b)*

B (a+b) (a+b)* (a+b)

C ((a+b) (a+b) (a+b))*

D (a+b) (a+b)*

Regulars and CFGs : MSQ

Q75. Which of the following operation is closed for finite languages but not closed for infinite languages?

		Fin	Inf
A	Kleene star	✗	✓
B	Union	✓	✓
C ✓	Subset	✓	✗
D	Substitution	✓	✓

Subset of Inf lang is ___may or may not be Inf___

subset of fin lang is ___fin lang___

$F_1 = \phi$ $\quad$ $F_2 = \{a\}$

$F_3 = \{\varepsilon\}$ $\quad$ $F_4 = \{a, \varepsilon\}$

a^* I_1	b^* I_2	a^*b^* I_3
I_4	I_5	I_6
I_6	I_8	I_7

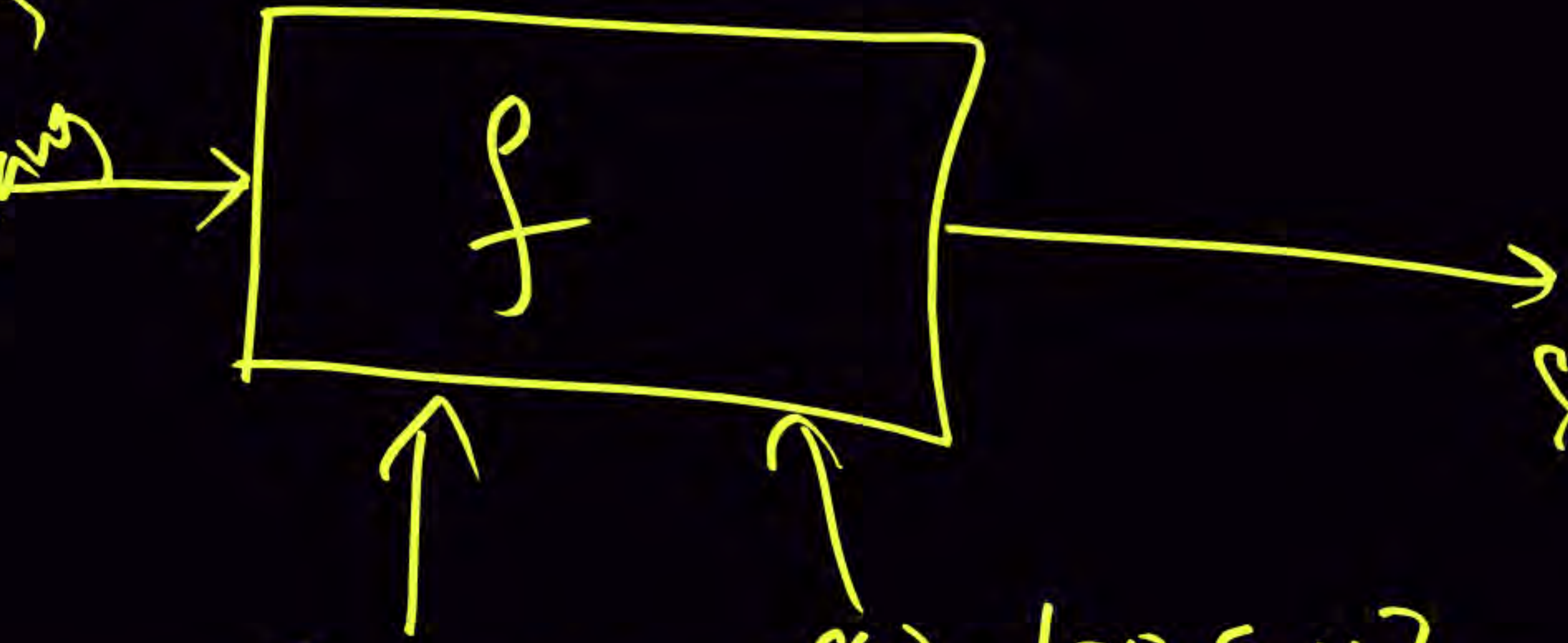
a^* Inf lang

ϕ is subset of a^*

$\underbrace{\phi}_{\text{not Inf}}$

$\{\varepsilon, aa\}$
finite lang

$L = \{ab, b\}$ finite lang



$f(L) =$ finite lang

$= \{f(a).f(b), f(b)\}$

$f(a) = \{0, 1\}$

$f(b) = \{00, \varepsilon, 11\}$

[MSQ]

#Q76. Consider the following language L:

$L = \{a, b, ab, baa\}$

Which of the following strings are present in the $\underbrace{\text{INIT}}_{\text{prefix}(L)}$ of L?

A. $\in$

B. aa

C. ba

D. b

$L = \{a, b, ab, baa\}$

$\text{pref}(L) = \{\text{pref}(a), \text{pref}(b), \text{pref}(ab), \text{pref}(baa)\}$

$= \{\varepsilon, a, b, ab, ba, baa\}$

L satisfies prefix property

iff

Every string of L is not a prefix to every other string in L.

① $L = \{a, ba, bab\}$ not satisfies prefix property

② $L = \{ab, ac, bac\}$ Satisfies prefix property.

[NAT]

#Q77. Consider the following statements:

[I]. Infinite union of regular languages is regular. Incorrect

[II]. Subset of finite language is regular. correct

[III]. Intersection of two non-regular languages $\boxed{\text{can}}$ be regular. possible correct

Total number of INCORRECT statements are $= 1$.

$$\underbrace{\{a^n b^n\}}_{\text{non reg}} \cap \underbrace{\{b^n a^n\}}_{\text{non reg}} = \underbrace{\{\varepsilon\}}_{\text{reg}}$$

[MSQ]

#Q78. Consider the following grammar G:

G: $S \rightarrow aAa \mid bAb$

$A \rightarrow aA \mid bA \mid a \mid b \Rightarrow (a+b)^+$

$B \rightarrow aA \mid bA \mid a \mid b \Rightarrow (a+b)^+$

$L = \underbrace{a(a+b)^+a + b(a+b)^+b}_{\text{reg lang}}$

The language generated by above grammar G is:

A. $L(G) = \{ww^R \mid w, x \in \{a, b\}^+\} = axa + bxb + aaxaa + abxba + \cdots$

B. $L(G) = \{wxw \mid w, x \in \{a, b\}^+\}$ not reg lang

C. $L(G) = \{a(a + b)^+a + b(a + b)^+b\}$

D. $L(G) = L(G)$ isCFL but not regular

[MCQ]

≥ 5

$\geq$ #states in minDFA (ignore dead)

#Q79. Consider the following regular expression:

$R = (aa)^* \cup (bb)^*$

Which of the following can't be the pumping length for L(R)?

A 2

B 5

C 7

D 9

[MSQ]

#Q80. Which of the following does not generate string 'baa'?

A $a^* (ba)^* b^*$

ε ba ___ ×

B $a^* b^* (ba)^* a$

ε ε ba a ✓

C $(ab^* + a)^* (ab)^* b^* a^*$

ε ε b aa ✓

D $(bba^* + b)^* a$

b a ×

bbaa

[NAT]

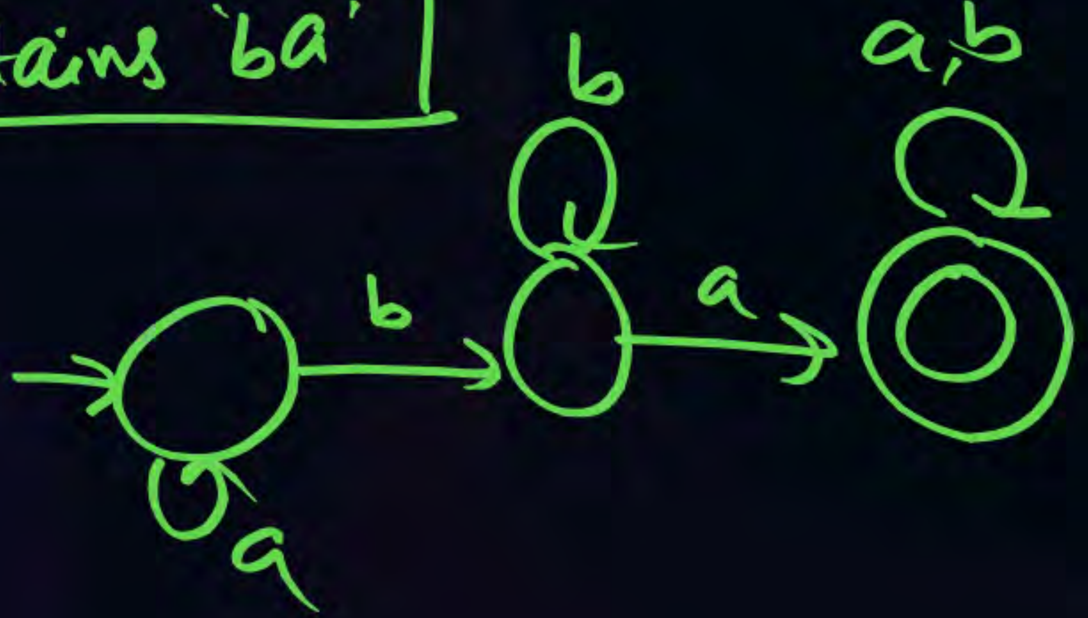
#Q81. Consider the regular expression R:

$R = (a + ba^*)^*\, ba\, (a + b)^*$

How many states are needed to design a DFA for above regular expression R?___

$R = (a+b)^*\, ba\, (a+b)^*$

$\boxed{\text{contains 'ba'}}$



$= 3$ //

[MCQ]

$L = S = a^3 a^* (\epsilon+b)^4$ atmost 4 b's

#Q82. Consider the following grammar G:

G: $S \rightarrow aaaA$

$A \rightarrow aA \mid B$

$B \rightarrow b \mid bb \mid bbb \mid bbbb \mid \epsilon$

$A = a^* B = a^* (\epsilon+b)^4$

$B = \epsilon + b + \cdots + b^4 = (\epsilon+b)^4$

The language generated by above grammar G is

A. $L(G) = \{a^m b^n \mid m \text{ divisible by 3 and } n \geq 4\}$

B. $L(G) = \{a^m b^n \mid m \geq 1 \text{ and } n < 5\}$

C. $L(G) = \{a^m b^n \mid \boxed{m > 2} \text{ and } \boxed{n < 5}\}$

$m \geq 3$

D. None of these

[MSQ]

Every string should not be a prefix to another string

#Q83. Which of the following $\boxed{\text{language satisfy the prefix property}}$?

A $L = \{a^n b^n \mid n \geq 1\}$ $= \{ab, aabb, aaabbb, \ldots\}$

B $L = \{wxw^R \mid w, x \in \{a, b\}^*\}$ $= (a+b)^*$ X

C $L = \{a^m b^{2m} \mid m \geq 1\}$ $= \{abb, aabbbb, \ldots\}$

D $L = \{w \in \{0, 1\}^* \mid n_0(w) = n_1(w)\}$

-- , 01, 0101

[NAT]

#Q84. Consider a language $L = \{w \mid w \in \{a, b\}^*, 6^{th}$ symbol from end is 'a'$\}$.
If number of states in NFA is A and number of states in DFA is B then the value of $A \times B$ is _____.

Min DFA : $2^6 = 64$ states $= A$

Min DFA : $6+1 = 7$ states $= B$

$A \times B = 64 \times 7$

$= 448$

[MSQ]

S → 0A | 1B
A → 10S
B → 01A | 0

#Q85. Consider the following grammars G_1 and G_2:

G_1: $S \rightarrow 0A \mid 1B$
$A \rightarrow \cancel{101C} \mid 10S$
$B \rightarrow 01\,A \mid 0$
$\cancel{D \rightarrow 00\,B \mid 10\,A}$

Regular Grammar
↳ always generates reg lang

G_2: $S \rightarrow AB$
$A \rightarrow 01 \mid 10$
$B \rightarrow 00 \mid 11$

Not reg grammar ⇒ {0100, 0111, 1000, 1011}
Finite lang

Which of the following is/are correct.?

A. $L(G_1)$ is regular.

B. $L(G_2)$ is regular.

C. $L(G_2)$ is finite regular.

D. $L(G_1)$ is CFL but not regular.

G_2 is not reg
$L(G_2)$ is reg

[MCQ]

#Q86. Consider the following grammars on $\Sigma = \{0, 1, 2\}$

G_1: $S \to AB$
$A \to 0A1 \mid \in$
$B \to 1B2 \mid \in$

G_2: $S \to 0S1 \mid B$
$B \to 1\,B2 \mid \in$

G_3: $S \to AB \mid B$
$A \to 0A1 \mid 01$
$B \to 1B2 \mid \in$

Which of the following grammars are equivalent?

A. G_1 and G_2 only

B. G_2 and G_3 only

C. G_1 and G_3 only

D. G_1 and G_2 only

[MCQ]

#Q87. Consider the following statements:

S_1: Pumping lemma can be used to prove that some of the languages are not regular using contradition.

S_2: Language L satisfies the pumping lemma iff L is regular.

Which of the following is correct?

A S_1 only

B S_2 only

C Both S_1 and S_2

D None the these

[MCQ]

#Q88. Finite automata can be used in which of the following?

A. String matching

C. Text editing

B. Lexical analysis

D. Infix to prefix conversion

[MCQ]

#Q89. Let L consist of all binary strings start with 1 and decimal value of binary number is divisible by 3. Which of the following is true?

A. L can be recognized by NPDA

C. L can be recognized by DPDA

B. L can be recognized by DFA

D. L can be recognized by NFA

[MSQ]

#Q90. Consider the following grammar G:

$S \rightarrow P \mid Q$

$P \rightarrow aPb \mid \lambda$

$Q \rightarrow aaQb \mid \lambda$

Which of the following is/are True?

A. G is ambiguous and $\{\lambda\}$ has two parse tree.

C. L(G) is accepted by PDA but not by DPDA.

B. L(G) is inherently ambiguous.

D. None of these.

THANK - YOU