CS & IT ENGINEERING

THEORY OF COMPUTATION

Regular Language [redacted]

Lecture No.- 02

By- Venkat sir

Recap of Previous Lecture

Topic ?????

Regular Language Detection

Topics to be Covered

Topic: Regular Language Detection

Topic: Pumping Lemma

{Closure Properties of Regular Languages}

$x, y \in (a+b)^*$

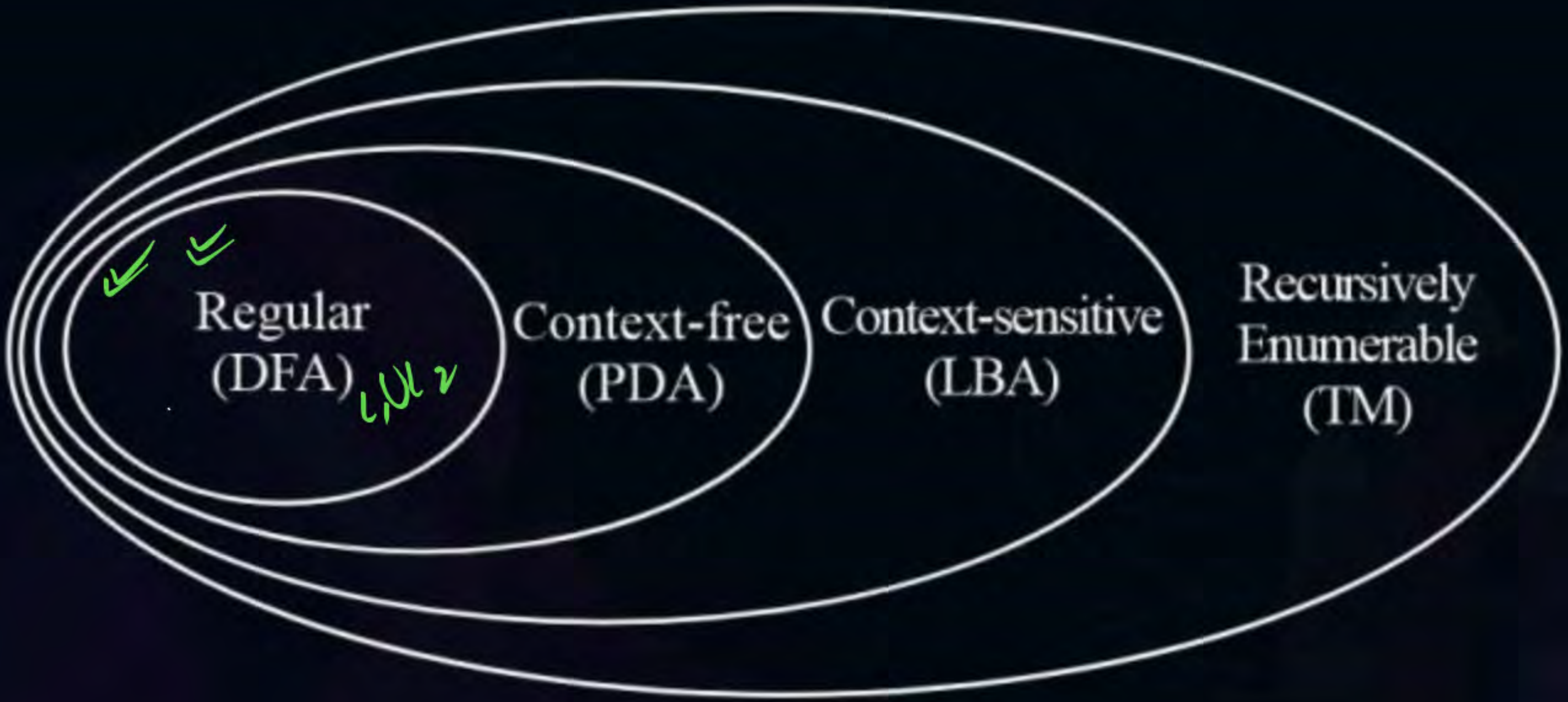
$L_1 = \{ x \$ y \mid n_a(x) = n_b(y) \} \Rightarrow$ Non regular

$L_2 = \{ xy \mid n_a(x) = n_b(y) \} \Rightarrow (a+b)^* \Rightarrow$ regular

$x \in (a+b)^*$

Topic : Theory of Computation

L_1 L_2



① Subset op

×

$$\{a^n b^n \mid n \geq 1\} \subseteq (a+b)^*$$

$a^* b^*$

closed ?

Subset of regular lang is may (or) may not regular.

Hence regular language not closed Under subset.

finite

② Union op

$F_1 \quad F_2$

$\uparrow \quad \uparrow$

$L_1, \; L_2$

$L_1 \cup L_2$ = always Regular | closed

(OR)

$\boxed{F_1 \times F_2}$

closed

$\{a^n\}$ $\{b^n\}$

③ Concatenation op

L_1 L_2

$\exists$ F_1 F_2

closed

$L_1 \cdot L_2 \Rightarrow$ always regular

$F_1 \xrightarrow[\epsilon]{} F_2$

(4) Intersection op

$$L_1 \cap L_2 \Rightarrow \text{always regular}$$

(and)

$L_1 \uparrow F_1$, $L_2 \uparrow F_2$

$F_1 \times F_2$

{closed}

⑥ Infinite Intersection op (not closed)

Yes

NO

$$L_1 \cap L_2 \cap L_3 \cap L_4 \cap \text{---} = \overline{L_1^c \cup L_2^c \cup L_3^c \cup L_4^c \cup}$$

$F_1 \times F_2 \times F_3$ ----

$$L_1 \cap L_2 = \overline{L_1^c \cup L_2^c}$$

not closed

closed

(7) Complement op

$L = \text{regular} = F$

$\Sigma^* - L$ is also regular

$L^c = (\Sigma^* - L) = F^c$

Interchange final and Non final states

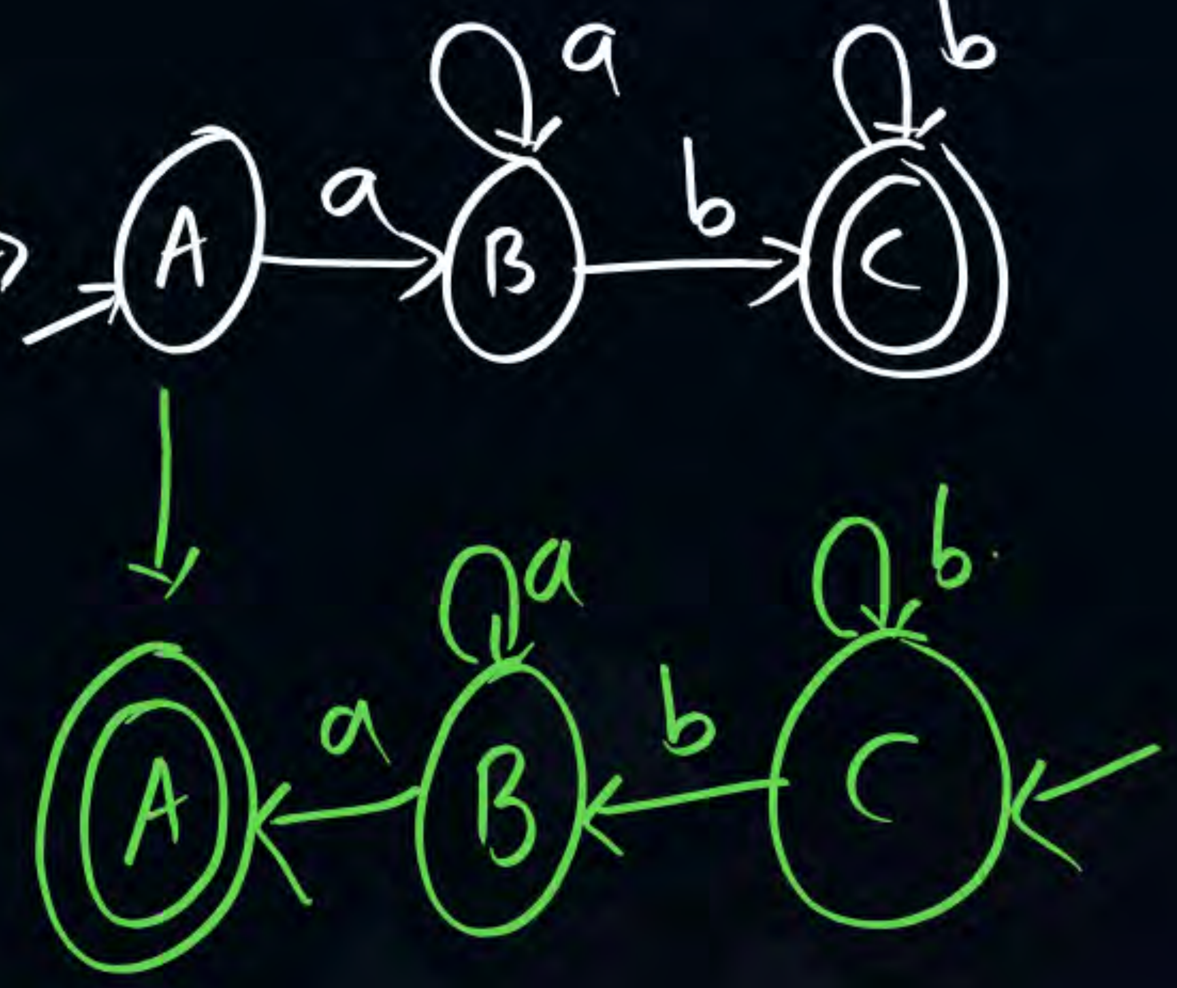
closed

(8) Reversal :

$L \Rightarrow$ regular $= \{a^m b^n\}$

$L^R = \{b^n a^m\}$ =

regular



Interchange Initial state and Final state

Reverse transition Direction

closed

(9) Kleene closure

$L \rightarrow$ regular $= r$

$L^* \Rightarrow r^* \Rightarrow$ always regular

(10) Positive closure

$L^+ = r^+ \Rightarrow$ always regular

(11) Difference op

$L_1, L_2 \}$ regular

closed

$$L_1 - L_2 = L_1 \cap L_2^c$$

$$= L_1 \cap \overline{L_2}$$

reg $\cap$ reg

(12) Prefix op (closed)

Prefix of a string } Sequence of leading symbols over given string

TOC	gate	delhi
ϵ	ϵ	ϵ
T	g	d
TO	ga	de
TOC	gat	del
	gate	delh
		delhi

- - - abc - - - n

How many prefixes?

(n+1) prefixes

(13) Suffixes (closed)

Suffix of a string:

Sequence of trailing symbols over given string

TOC

ϵ

C

OC

TOC

gate

ϵ

e

te

ate

gate

abc...n

$n+1$ Suffixes

(14) Substitution op

closed

$\Sigma \longrightarrow \Delta$

$\{a\} \quad \{0,1\}$

$\boxed{L = aa}$

$S(L) = S(a)\,S(a)$

$S(L) = (0+1)(0+1)(0+1)(0+1)$

$S(a) = \{00, 01, 10, 11\}$

$\boxed{S(a) = (0+1)(0+1)}$

$L = a^*$

$S(L) = (S(a))^*$

$= ((0+1)(0+1))^*$

(15) Homomorphism op } It is a Substitution in which symbol is replaced by Single String

closed

$$L = a^* b^*$$

$$\left\{ \begin{array}{l} h(a) = 01 \\ h(b) = 00 \end{array} \right\}$$

$$h(L) = h(a)^* \, h(b)^*$$

$$= (01)^* (00)^*$$

(16) Inverse Homomorphism op {Applying Homomorphism in reverse)

string replaced by symbol.

closed

$$h(a) = 00$$

$$h(b) = 10$$

$$L = \{00, 10\}$$

$$h^{-1}(L) = \{a, b\}$$

(15) Homomorphism op

=

(16) Inverse Homomorphism op

(5) Infinite Union of

$\{L_1, L_2, L_3 \ldots\}$ = regular

$L_1 \cup L_2 \cup L_3 \cup L_4 \cup \ldots$

$\{ab\} \cup \{a^2b^2\} \cup \{a^3b^3\} \cup \{a^4b^4\} \ldots = \{a^nb^n\}$

Nonregular

may (or) may not regular

not closed

(Q) How many states in $L_1 \cap L_2$ min DFA where

$$\phi \left\langle \begin{array}{l} L_1 = \underline{(a+b)^* a} \rightarrow F_1 \\ L_2 = \underline{(a+b)^* b} \rightarrow F_2 \end{array} \right.$$

$\underline{\underline{L_1 \cap L_2}}$

$F_1 \times F_2 = \Big\}$

(Q) Which of the following is true?

$\{a^n b^n\} \subseteq \{a^n b^n c^m\}$

(a) Subset of any Infinite language is Regular

(b) Subset of any Non regular language is Regular

(c) Subset of any finite language is regular

(d) none

Topic : Pumping Lemma

$\{a^n b^n \mid n \geq 1\}$

Non reg $\rightarrow \boxed{\text{P.L}} \rightarrow$ Non reg

#Q. To Prove a Language L is Non-Regular

1. Assume L is Regular
2. There exist F.A for L and n is no. of states in that F.A
3. Select some string W from L such that $|W| > n$.
4. Divide W into XYZ such that $|xy| <= n$ and $|y| > 0$.
5. Find a suitable integer i such that UV^iW is not belongs to L.

Then L is not Regular.

Q

If $L_1 = \{a^n \mid n \geq 0\}$ and $L_2 = \{b^n \mid n \geq 0\}$, consider

I. $L_1 \cdot L_2$ is a regular language → regul

II. $L_1 \cdot L_2 = \{a^n b^n \mid n \geq 0\}$ → false

Which one of the following is CORRECT?

$a^* b^*$

(A) Only I

(B) Only II

(C) Both I and II

(D) Neither I nor II

[2014-Set2: 1 Mark]

Q

Consider the following two statements:

I. If all states of an NFA are accepting states then the language accepted by the NFA is Σ^*. → false

II. There exists a regular language A such that for all language B, $A \cap B$ is regular. → true

[2016-Set2: 2 Marks]

Which one of the following is CORRECT

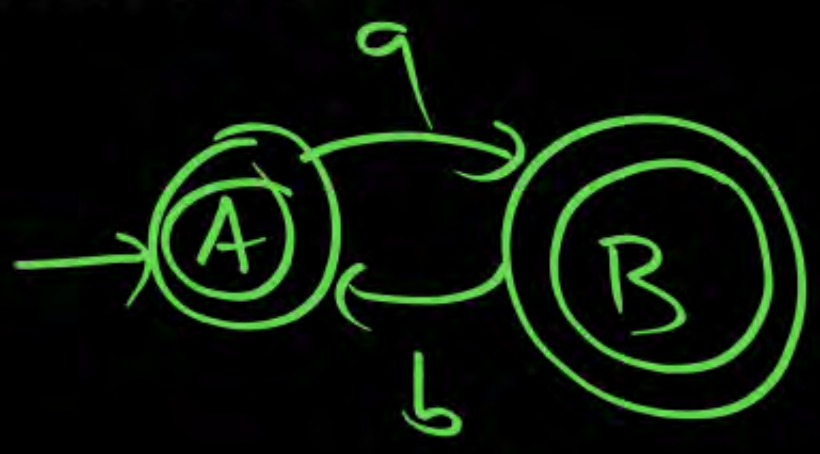
(A) Only I is true

(B) Only II is true

(C) Both I and II are true

(D) Both I and II are false

aa



$A \cap B$

$\{\epsilon\} \cap$ ____

2 mins Summary

Topic One

Topic Two

Topic Three

Topic Four

Topic Five

THANK - YOU