CS & IT ENGINEERING

Theory of Computation

Lecture No.- 08

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Recap of Previous Lecture

Topic Regular Languages

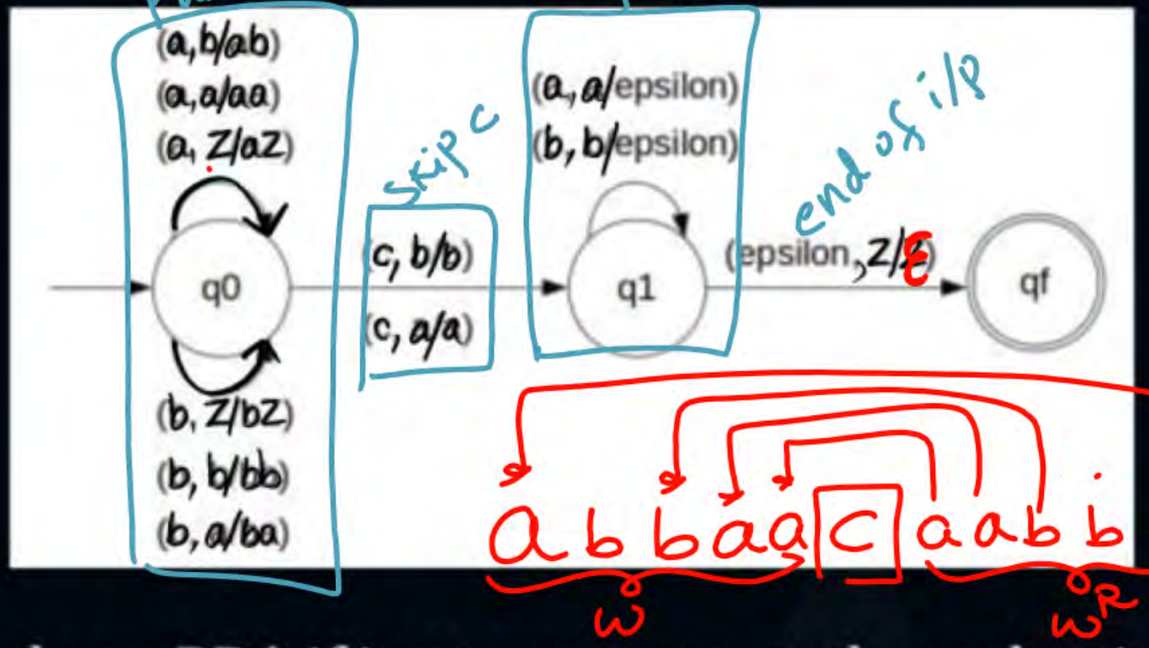
Topic Context Free Languages

Topics to be Covered

- Topic: Regular Languages
- Topic: Context Free Languages
- Topic: Turing Machine
- Topic: Undecidability Concepts

[NAT]

#Q100. Consider the following PDA:



Initially Z is on stack.

Which of the following is accepted by above PDA if it uses empty stack mechanism?

A $\{wcw \mid w \in \{a,b\}^*\}$ not CFL

B $\{wcw^R \mid w \in \{a,b\}^*\}$

C $\{ww^R \mid w \in \{a,b,c\}^*\}$

D None of these

[NAT]

#Q101. Consider the following CFG:

$$S \to S_1 | S_2$$
$$S_1 \to X | XXS_1$$
$$S_2 \to T_aT_b | T_bT_a$$
$$T_a \to XT_aX | a$$
$$T_b \to XT_bX | b$$
$$X \to a | b$$

S_2 guarantees
- generates even length
- not ww form

$S_1 \Rightarrow$ odd length strings

$S_2 \Rightarrow \{w_1w_2 \mid w_1, w_2 \in \{a,b\}^*, |w_1| = |w_2|, w_1 \neq w_2\}$

Which of the following is represented by above CFG?

A. Complement of $\{ww \mid w \in \{a,b\}^*\}$

B. Complement of $\{ww^R \mid w \in \{a,b\}^*\}$

C. $\{ww^R \mid w \in \{a,b,c\}^*\}$

D. None of these

$$L = \{ww \mid w \in \{a,b\}^*\} \Rightarrow \text{not CFL}$$

$$\overline{L} = \{ww \mid w \in \{a,b\}^*\} \Rightarrow \text{CFL}$$

$$L = \{ ww / w \in \{a,b\}^* \} = \{ \varepsilon, aa, bb, aaaa, abab, baba, bbbb, \ldots \}$$

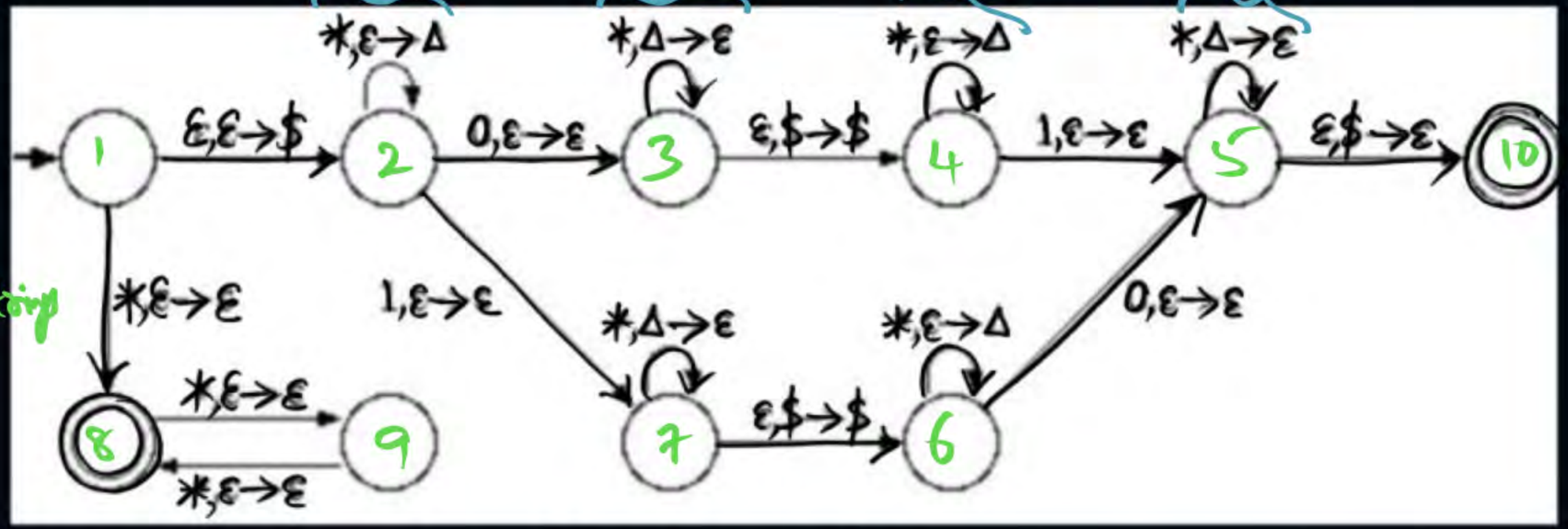
= set of all even length strings in ww form

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

= Set of all odd length strings $\cup$ Set of all even lengths not in ww form

[NAT]

#Q102. Consider the following CFG. $ is bottom of stack symbol. * is either 0 or 1.



[8] = set of all odd length strings

Which of the following is represented by above CFG?

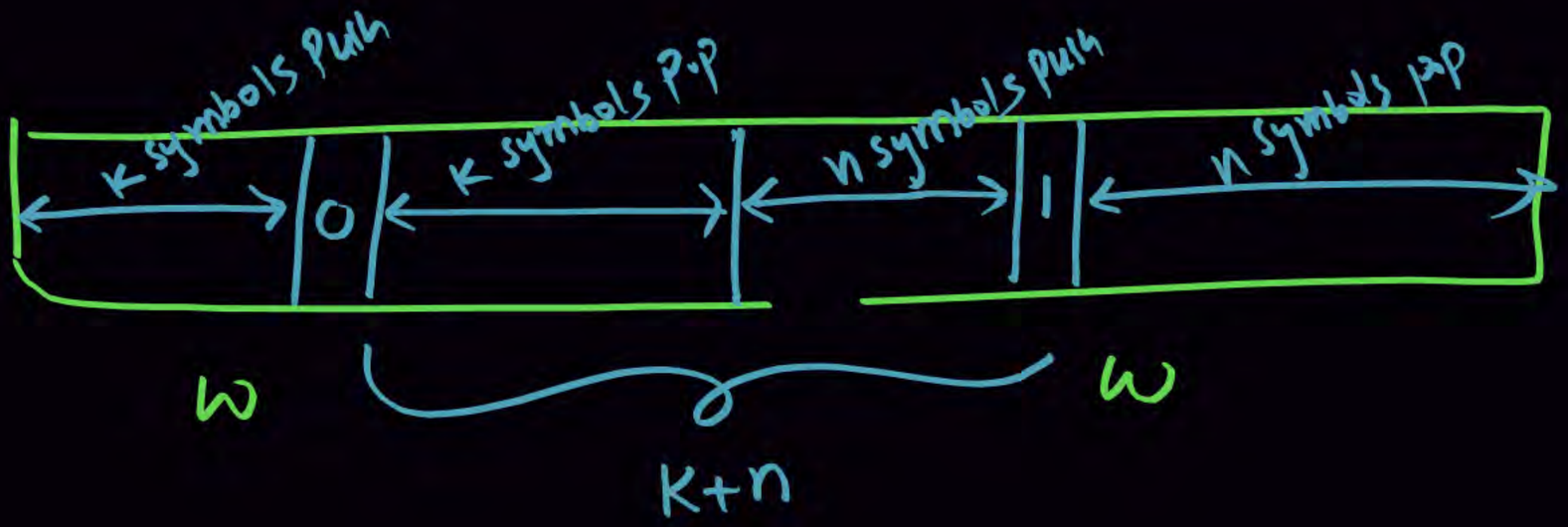
A Complement of $\{ww \mid w \in \{a,b\}^*\}$

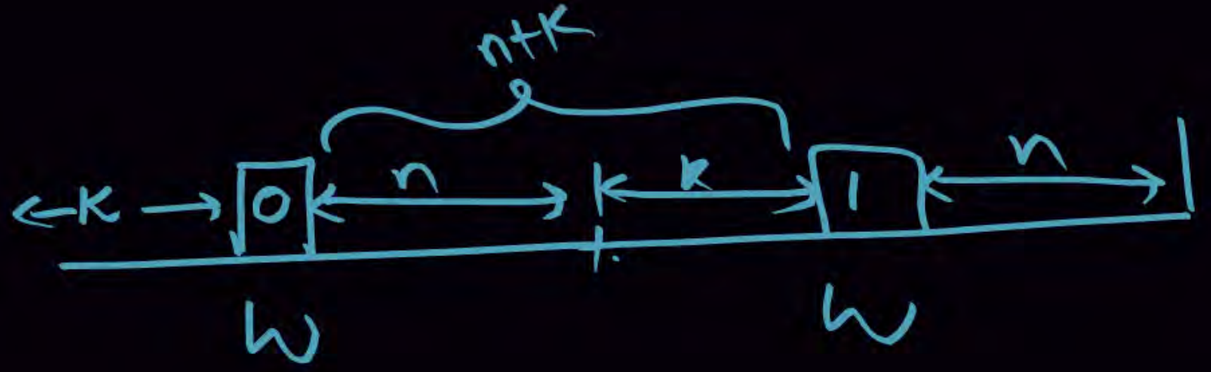
B Complement of $\{ww^R \mid w \in \{a,b\}^*\}$

C $\{ww^R \mid w \in \{a,b,2\}^*\}$

D None of these

Even length not in ww form





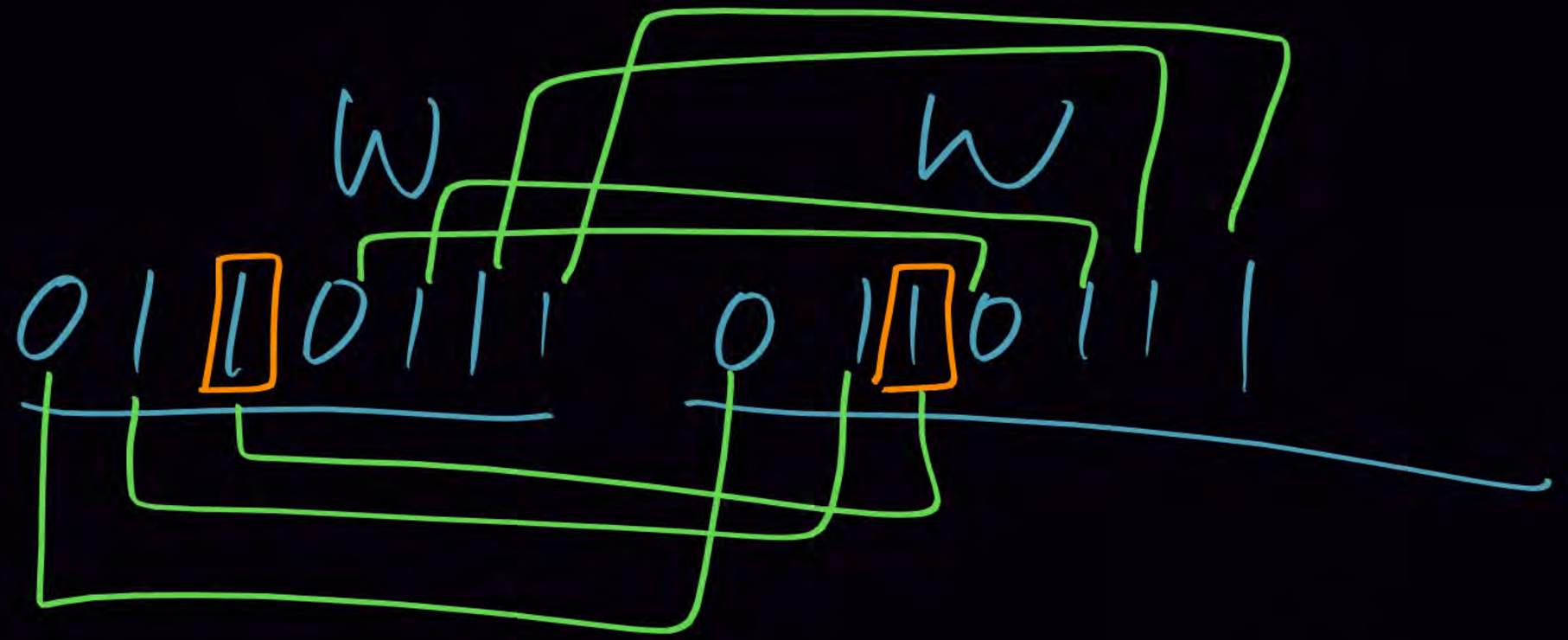
$w \in \{0,1\}^*$

$\overline{ww}$

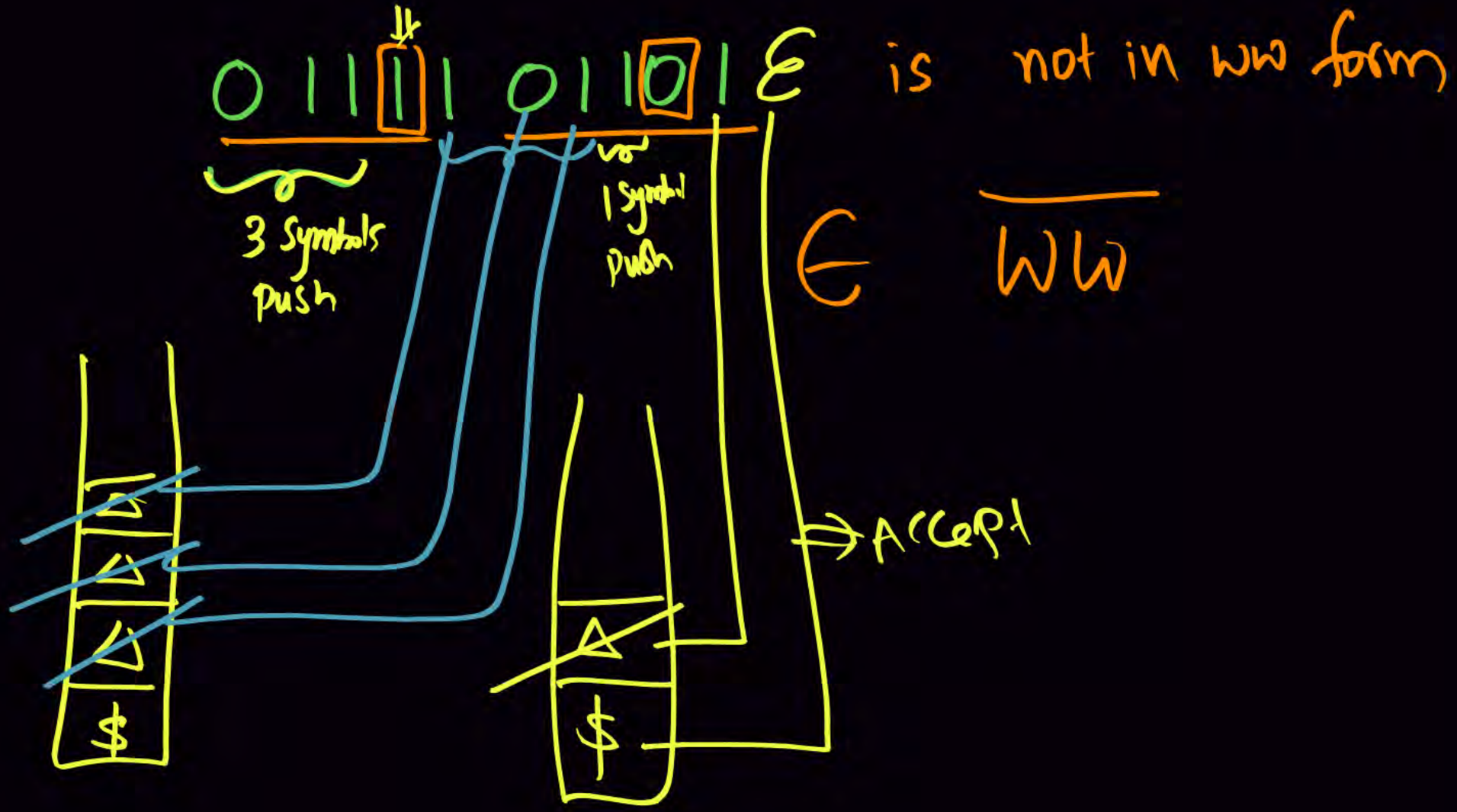
ww

All odd length strings

All even length strings not in ww form


w
w
0 1 # 0 1 1 1 0 1 # 0 1 1 1


K
Push
1
n
K
0
n
Pop
Pop
K symbols
K+n
push n sym.



is not in ww form

$\epsilon \overline{WW}$

[MCQ]

#Q103. Consider the following CFG..

$$S \rightarrow 0S1S1S \mid 1S0S1S \mid 1S1S0S \mid \in$$

ε ✓
011 ✓
101 ✓
110 ✓

Which of the following strings are generated by above CFG?

$n_1(w) = 2\, n_0(w)$

A Binary strings with twice as many 1's as 0's.

B Binary strings with twice as many 11's as 00's.

C Binary strings with twice as many 0's as 1's.

$n_0(w) = 2\, n_1(w)$

D None of these

[MCQ]

#Q104. Consider the following CFG..

$S \rightarrow AB \mid BA$
$A \rightarrow CAC \mid a$
$B \rightarrow CBC \mid b$
$C \rightarrow a \mid b$

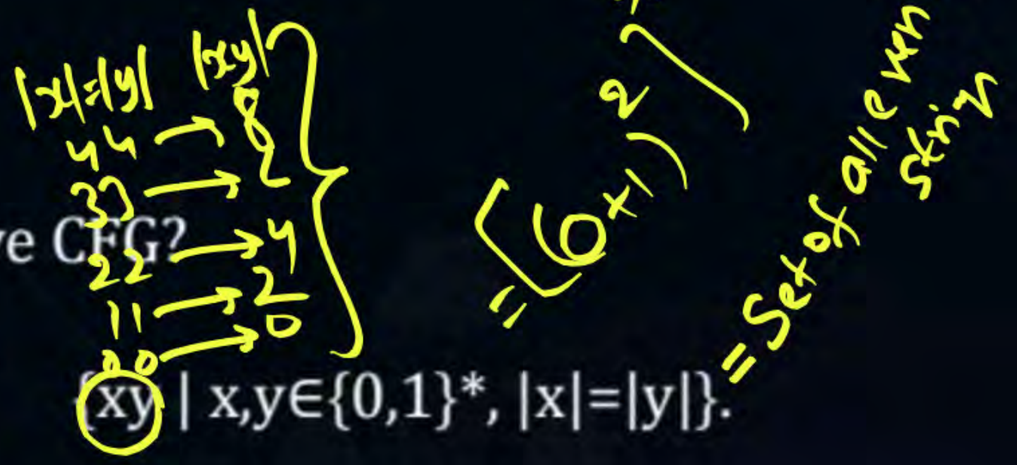
Which of the following strings are generated by above CFG?

A {xy | x,y∈{0,1}*, |x|=|y|, x≠y}.

B {xy | x,y∈{0,1}*, |x|=|y|}.

C {xy | x,y∈{0,1}*, x=y}.

D {xy | x,y∈{0,1}*, |x|=|y|, x=y}.



[MCQ]

#Q105. Consider the following CFG..

$S \rightarrow 0A \mid 1B$
$A \rightarrow 0AA \mid 1S \mid 1$
$B \rightarrow 1BB \mid 0S \mid 0$

$L = \{01, 10, 0011, 1100, 0101, 0110, \cdots\}$

Which of the following language is generated by above CFG?

A $\{w \mid w \in \{0,1\}^+, n_0(w) = n_1(w)\}$.

B $\{w \mid w \in \{0,1\}^*, n_0(w) \neq n_1(w)\}$.

C $\{w \mid w \in \{0,1\}^*, n_0(w) < n_1(w)\}$.

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

[MSQ]

#Q106. Suppose L1 and L2 are Turing Recognizable Languages.

Which of the following is Turing Recognizable?

U ✓
∩ ✓
. ✓
— ✗

CDSFI
RELs
⇩
Complement
Difference
Subset
Inf...
Finite Difference
Not closed

A ✓ L1 ∪ L2 = REL₁ ∪ REL₂ ⇒ REL

B ✓ L1 ∩ L2 — REL₁ ∩ REL₂ ⇒ REL

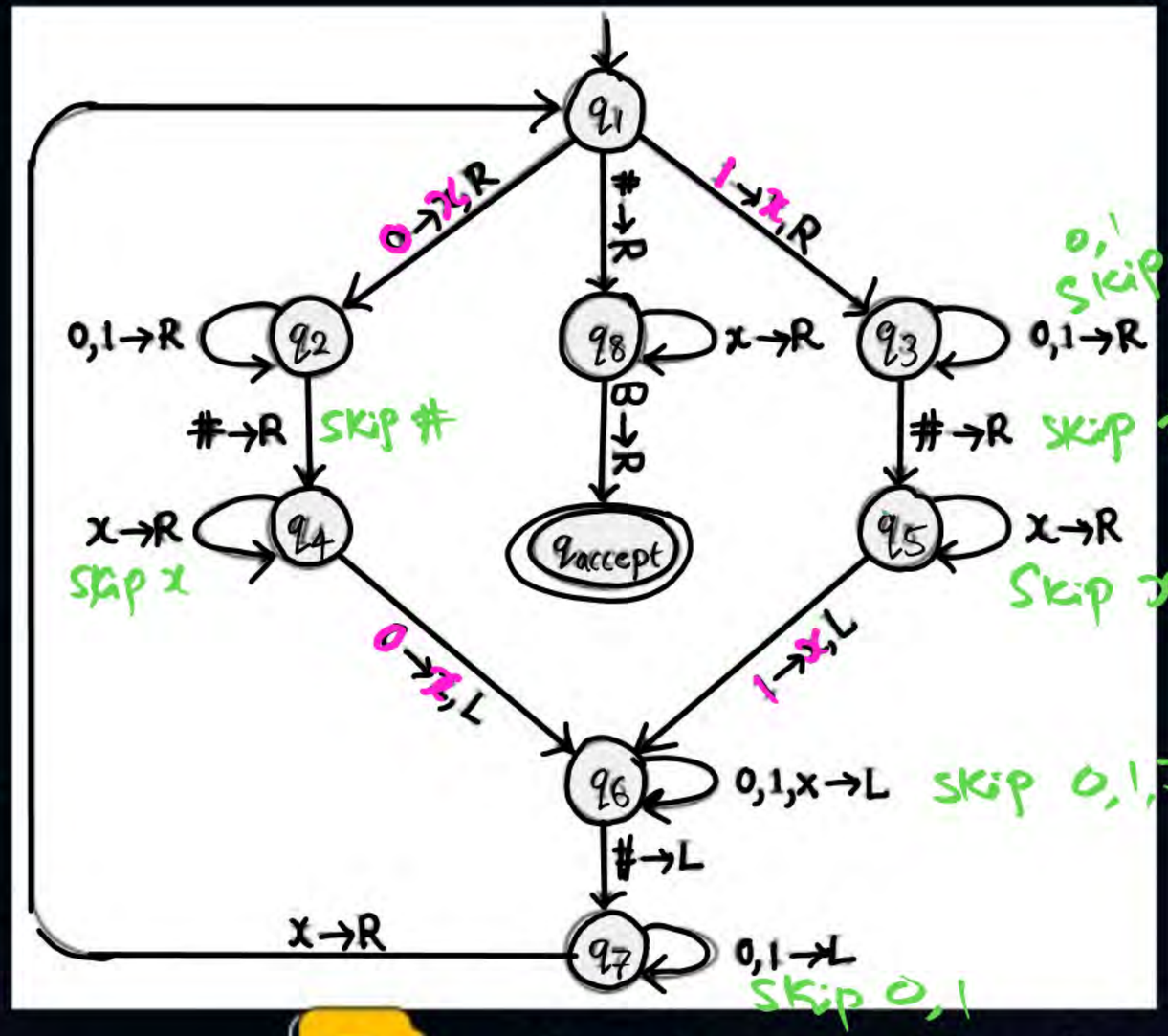
C ✗ L1 - L2 = REL₁ - REL₂ ⇒ Need not be REL

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

D ✓ L1 L2
REL₁ . REL₂ ⇒ REL

[MCQ]

#Q107. Language accepted by following TM is ___



A {ww| w∈{a,b}*}

B Complement of {ww^R| w∈{a,b}*}

C {ww^R| w∈{a,b,c}*}

D None of these

[NAT]

#Q108. How many of the following statements are equivalent to TM?

1. Multi-tape Turing machines
2. Turingmachines with Bi-infinite Tape
3. Nondeterministic Turing machines
4. Postmachines or Queue automaton
5. PDAs with two stacks
6. Counter machines

= 6

Equivalent to TM

- DTM
- NTM
- UTM
- 2 stack PDA
- one way infinite tape TM
- 2-way " " TM
- Single head TM
- multi head TM
- 1-D tape TM
- 2-D tape TM
- ⋮

[MSQ]

#Q109. Which of the following does by Turing Machine?

A. Sorting a list

B. String Matching

C. Graph Search

D. Searching a list

Program

$\cong$

TM

$\cong$

Computer

Algorithm

$\cong$

Halting program

$\cong$

HTM

[MSQ]

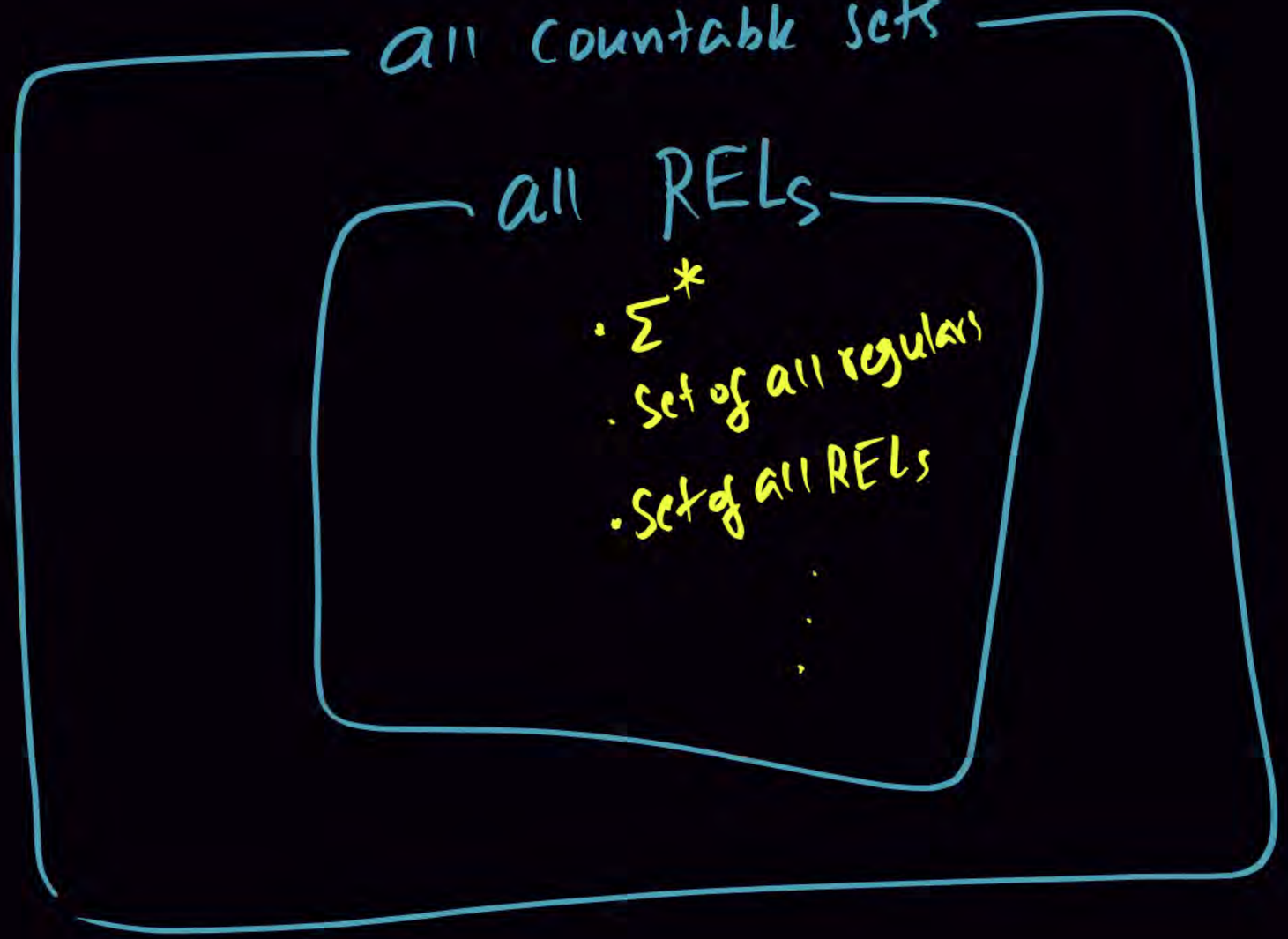
#Q110. Which of the following is countable?

A Set of binary strings $= \Sigma^* = (0+1)^*$ $\{\varepsilon, 0, 1, 00, 01, 10, 11, \ldots\}$

B Set of regular languages $L = \{R_1, R_2, R_3, \ldots\}$ TM exist, It is also REL

C Set of RELs $L = \{REL_1, REL_2, REL_3, \ldots\}$ It is also REL, TM exist

D None of these


all Countable sets
all RELs
• Σ^*
• Set of all regulars
• Set of all RELs

[MCQ]

#Q111. Which of the following is TRUE?

1. If both L and complement of L are RE ,then L is recursive.
2. If L is recursive then so is the complement of L.

A Only 1

B Only 2

C Both 1 and 2

D None of these

[MSQ]

#Q112. Which of the following L is Recursively Enumerable Language?

A L is Regular

B L is Decidable

C L is Enumerable

D L is Undecidable

[MSQ]

#Q113. If L is recursive language, then complement of L is ___

A Recursive

B Undecidable

C RE

D CFL

[MCQ]

#Q114. Consider the following statements.

I. Every decidable set is countable
II. Every RE set is countable
III. Every countable set is RE

How many of the above statements is/are true?

A 0

B 1

C 2

D 3

[MSQ]

#Q115. Complement of not REL is _____

A Recursive

B Undecidable

C REL

D None of these

X is countable set

iff

$f: X \to Y$ is Bijective

where Y is known countable.

THANK - YOU