

CS & IT ENGINEERING

Compiler Design

Lecture No.- 01

Mallesham Devasane Sir



Topics to be Covered



Topic

Lexical Analysis & Syntax Analysis

- Tokens
- Functionality
- Lexical Errors

longest Prefix Rule

FIRST & FOLLOW
TOP-down parsing



Lexical Analysis & Syntax Analysis : MCQ



#Q1. Which of the following never be a token?

- A you² *Identifier ✓*
- B m²e *Identifier ✓*
- C 2we *invalid seqn.*
- D None of these



Lexical Analysis & Syntax Analysis : MCQ

#Q2. If $T_1 = a^*$, $T_2 = bb^*$, and $T_3 = aa^*bb^*$ then find the number of tokens produced by lexical analysis for input 'aabbbabbba?'



Σ	$b\Sigma = b$
τ	$b\bar{b}$
aa	$b\bar{b}b$
aaa	$b\bar{b}\bar{b}$
$aaaa$	$b\bar{b}\bar{b}\bar{b}$
$aaaaa$	$b\bar{b}\bar{b}\bar{b}\bar{b}$



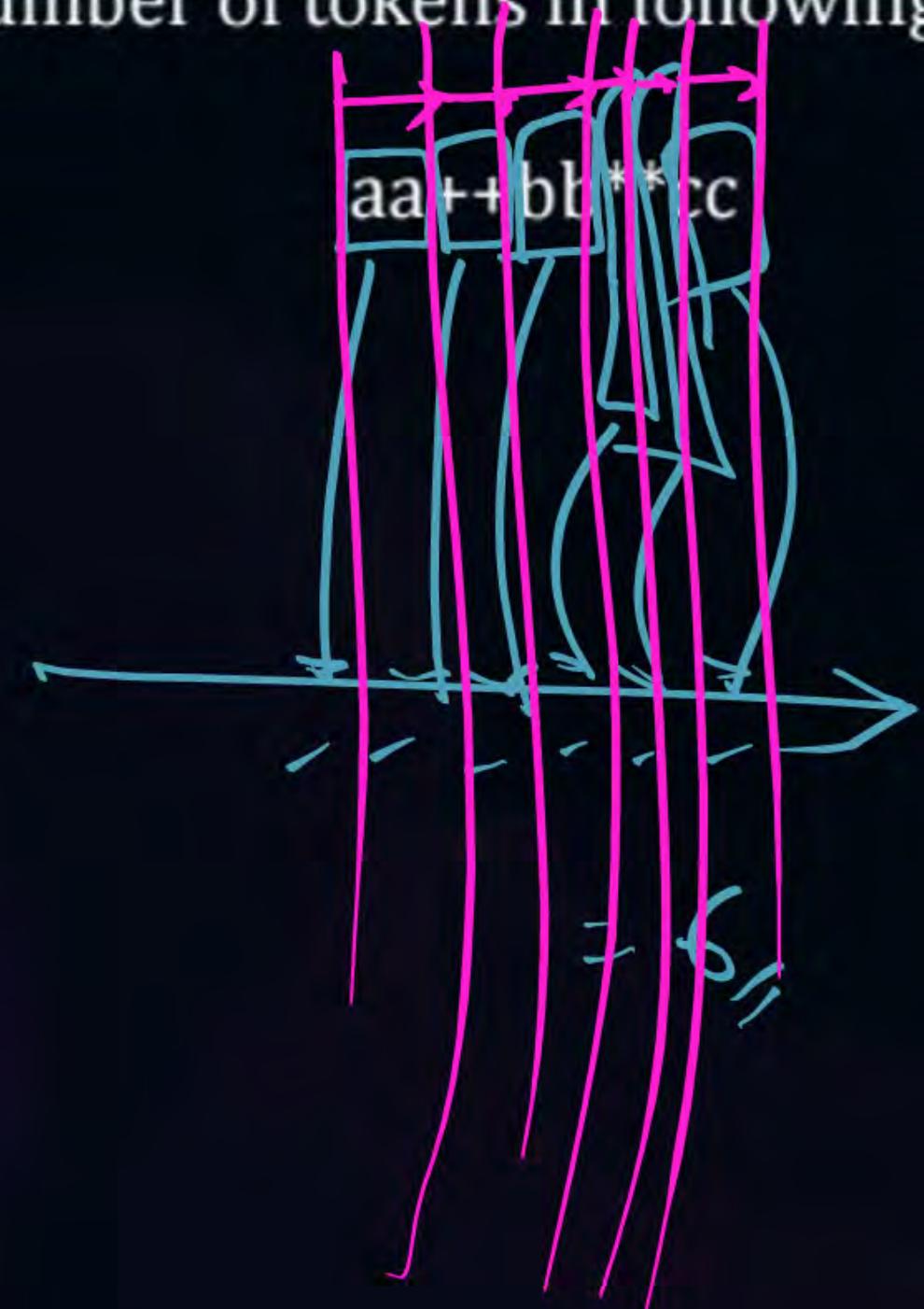
NAT



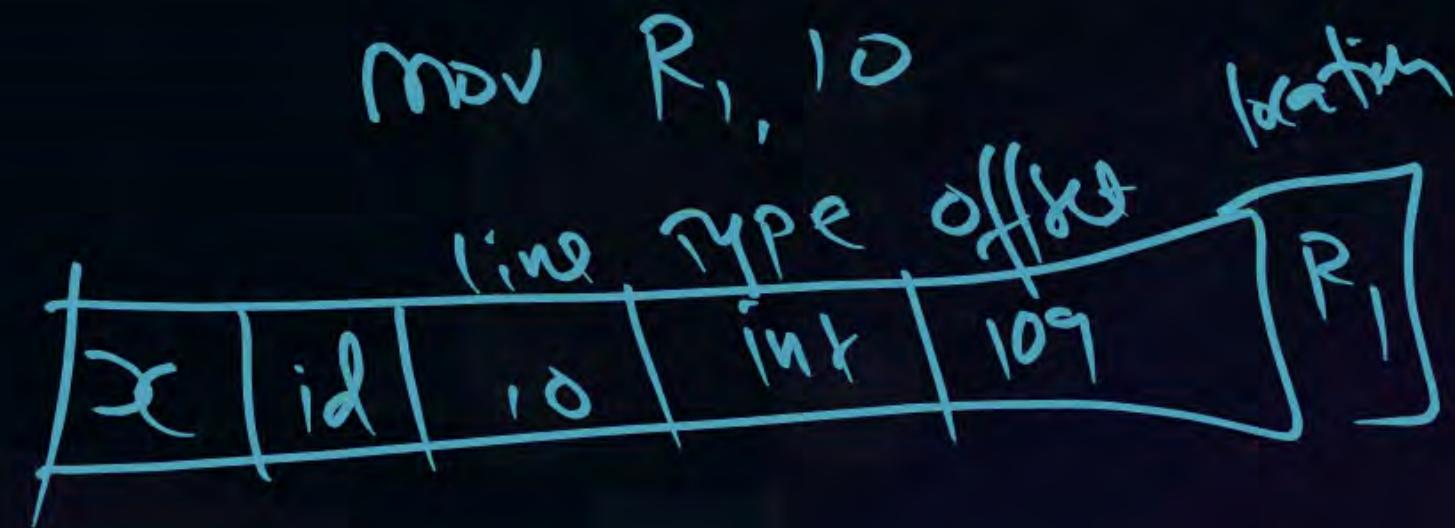
Lexical Analysis & Syntax Analysis : NAT



#Q3. Find the number of tokens in following C expression.



$x = 10$



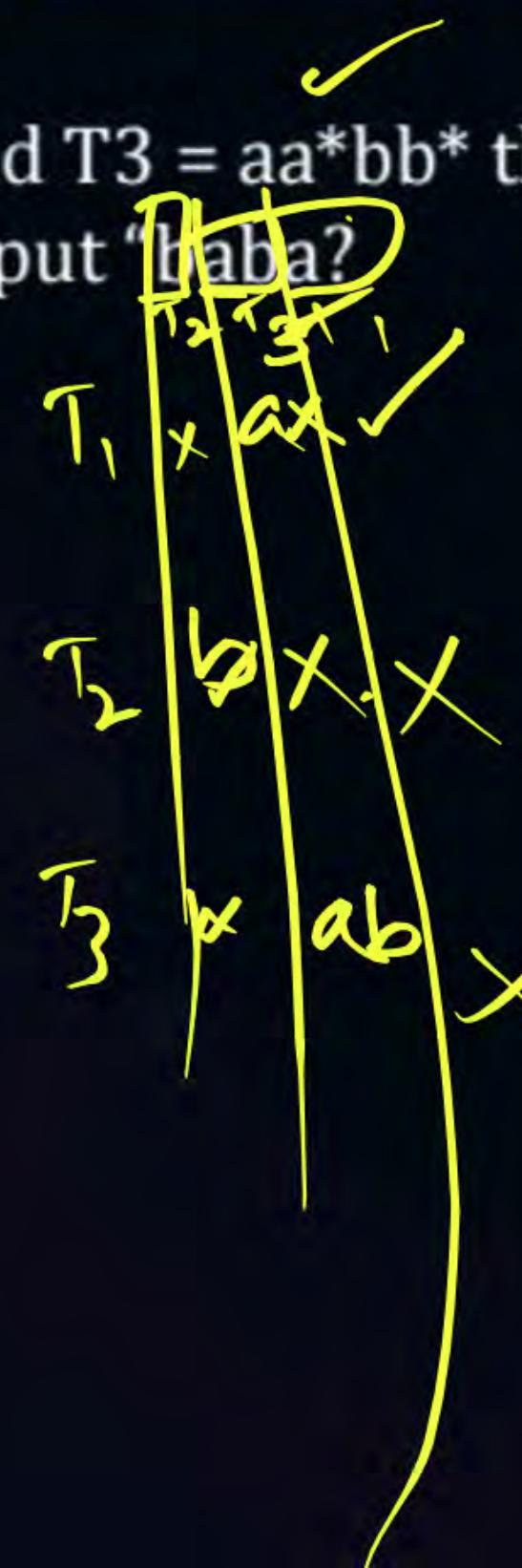


Lexical Analysis & Syntax Analysis : MCQ



#Q4. If $T_1 = aa^*$, $T_2 = bb^*$, and $T_3 = aa^*bb^*$ then find the token sequence generated by lexical analysis for input "bababaa?"

- A $T_3T_2T_1$
- B $T_2T_3T_1$
- C $T_1T_3T_2$
- D None of these





Lexical Analysis & Syntax Analysis : MSQ



#Q5. Which of the following produces lexical error?

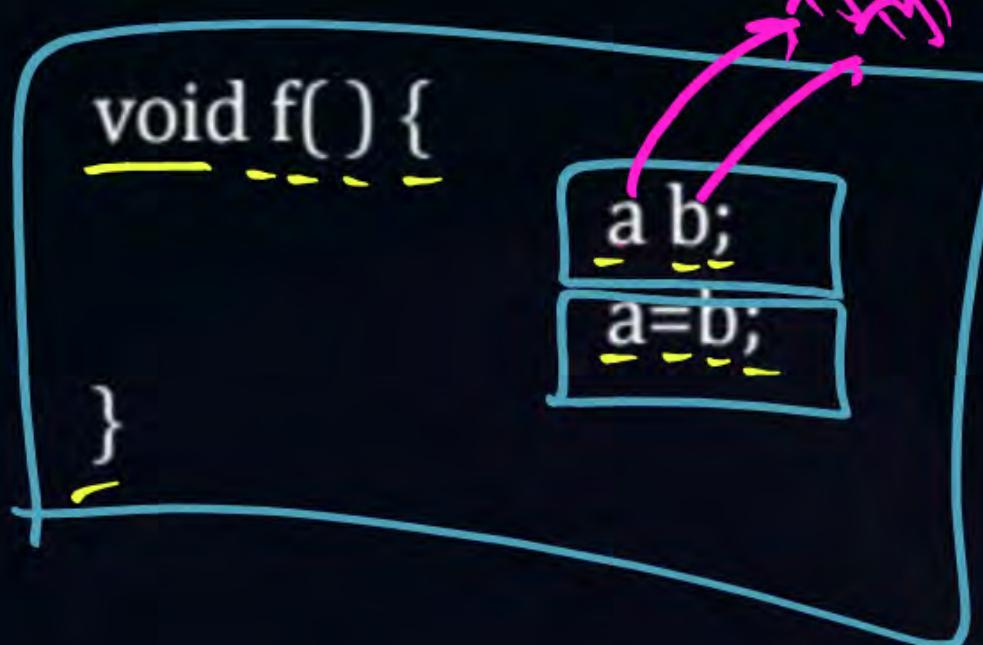
- A void main(){123+456} no lex error
- B void main(){123+45a} lex error
- C void main(){1a3+456} lex error
- D void main(){1a3+45a} lex error



Lexical Analysis & Syntax Analysis : MCQ



#Q6. Which one of the following error produced by compiler?



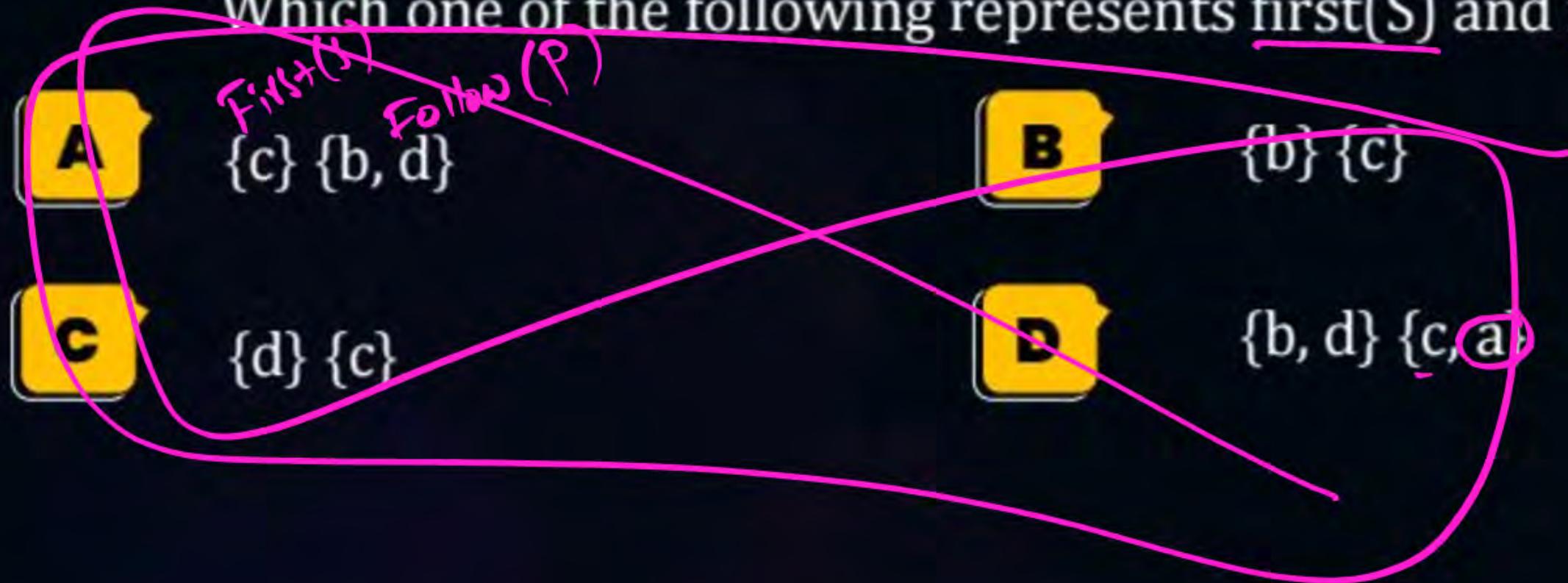
- A** Lexical Error
- B** Semantic Error
- C** Syntax Error
- D** None of these

#Q7. Consider the following grammar

$$S \rightarrow Aa \mid bPc \mid dc \mid bda$$

$$P \rightarrow d$$

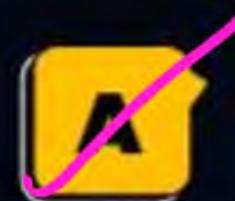
Which one of the following represents first(S) and follow(P) respectively?



#Q8. Consider the following grammar:

$$\begin{aligned} S &\rightarrow BA \\ A &\rightarrow BA \mid \epsilon \\ B &\rightarrow DC \\ C &\rightarrow *DCB \mid \epsilon \\ D &\rightarrow (S) \mid id \end{aligned}$$

FIRST (S) will be same as that of



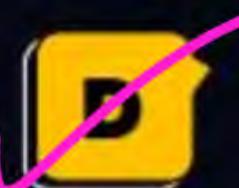
$\text{FIRST}(B) = \{(, id\}$



$\text{FIRST}(A) = \{\epsilon, (, id\}$



$\text{FIRST}(C) = \{*, \epsilon\}$



$\text{FIRST}(D) = \{(, id\}$

[MCQ]

#Q9. Consider the following productions:

$$S \rightarrow aABe$$

$$A \rightarrow \underline{A}bc \mid b$$

$$B \rightarrow d$$

A

$$\text{FIRST}(S) = \{a, b\} = \{a\}$$

B

$$\text{FIRST}(A) = \{b, d\} = \{b\}$$

C

$$\text{FIRST}(A) = \{b\}$$

D

None of the above

#Q10. Symbol table is modified during which phase of a compiler?

- A** Lexical
- B** Semantic
- C** Both (a) and (b)
- D** None of these

int x ;

x	id	int	

#Q11. Which of the following statements not having syntax error?

- A If (a); $f(a);$
- B For (p, q, r); $f(p,q,r);$
- C While (p, q);
 $f(p,q);$
 \equiv
- D None of these

#Q12. How many tokens are generated by the lexical analyzer, if the following program has no lexical error?

```
main()
{
    int x, y;
    fl/*gate oat z;
    x =/*exam*/10;
    y = 20;
}
```

#Q13. Consider the following C program

```
1. main() {  
2.     int a = 2, b = 3;  
3.     char *x;  
4.     x = &a = &b;  
5.     a = 1xab;  
6.     printf("%d%d", a, *x);  
7. }
```

If scanner reads an entire program then find the line number in which lexical error is produced.

#Q14. Consider the following grammar.

$$S \rightarrow (S) \mid SS \mid \epsilon$$

Find the number of terminals in follow set of S.

#Q15. Which of the following is/are token in C language?

- A** Semicolon
- B** Identifier
- C** Keyword
- D** White space

#Q16. Consider the following grammar G:

G:

$$S \rightarrow Aa \mid B$$

$$B \rightarrow$$

$$A \rightarrow \epsilon$$

What is the first (S) ?

A

{a}

B

{A, B}

C

{a, ϵ }

D

None of these



2 mins Summary



Topic

Tokens ✓

Topic

Longest prefix rule ✓

Topic

Functionality of lexical analysis ✓

Topic

First and Follow ✓

Topic

Syntax errors ✓

THANK - YOU

CS & IT ENGINEERING

Compiler Design

Lecture No.- 02

Mallesham Devasane Sir



Recap of Previous Lecture



Topic

Lexical Analysis

Topic

Syntax Analysis

Topics to be Covered



Topic

Lexical Analysis & Syntax Analysis



Lexical Analysis & Syntax Analysis : NAT



#Q12. How many tokens are generated by the lexical analyzer, if the following program has no lexical error?

```
main()
{
    int x, y;
    fl/*gate oat z;
    x =/*exam*/10;
    y = 20;
}
```

= 12
,,
" "



Lexical Analysis & Syntax Analysis : NAT



#Q13. Consider the following C program

```
1. main() {  
2.     int a = 2, b = 3;  
3.     char *x;  
4.     x = &a = &b;  
5.     a = 1xab; ←  
6.     printf("%d%d", a, *x);  
7. }
```

// \$
lexical error

If scanner reads an entire program then find the line number in which lexical error is produced.



Lexical Analysis & Syntax Analysis : NAT



#Q14. Consider the following grammar.

$$S \rightarrow (S) \mid SS \mid \epsilon$$

Find the number of terminals in follow set of S.

= 3



$$\text{Follow}(S) = ?$$

$$= \{ \$,), (\}$$



Lexical Analysis & Syntax Analysis : MSQ



#Q15. Which of the following is/are token in C language?

- A** Semicolon ✓
- B** Identifier ✓
- C** Keyword ✓
- D** White space X

ABC



Lexical Analysis & Syntax Analysis : MCQ



#Q16. Consider the following grammar G:

$$G:$$
$$S \rightarrow Aa \mid B$$
$$B \rightarrow \epsilon$$
$$A \rightarrow \epsilon$$

What is the first (S) ?

A {a}

B {A, B}

C {a, ϵ } X

D None of these

#Q17. Which of the following statements not having syntax error?

- A if (a);
B If(a);
C while (p, q);
D If (a);
- (Identifiers)*

- B for (p, q, r);
C a, b, c, d;
D if (a)
- (Keywords)*

#Q18. Consider the following grammar G:

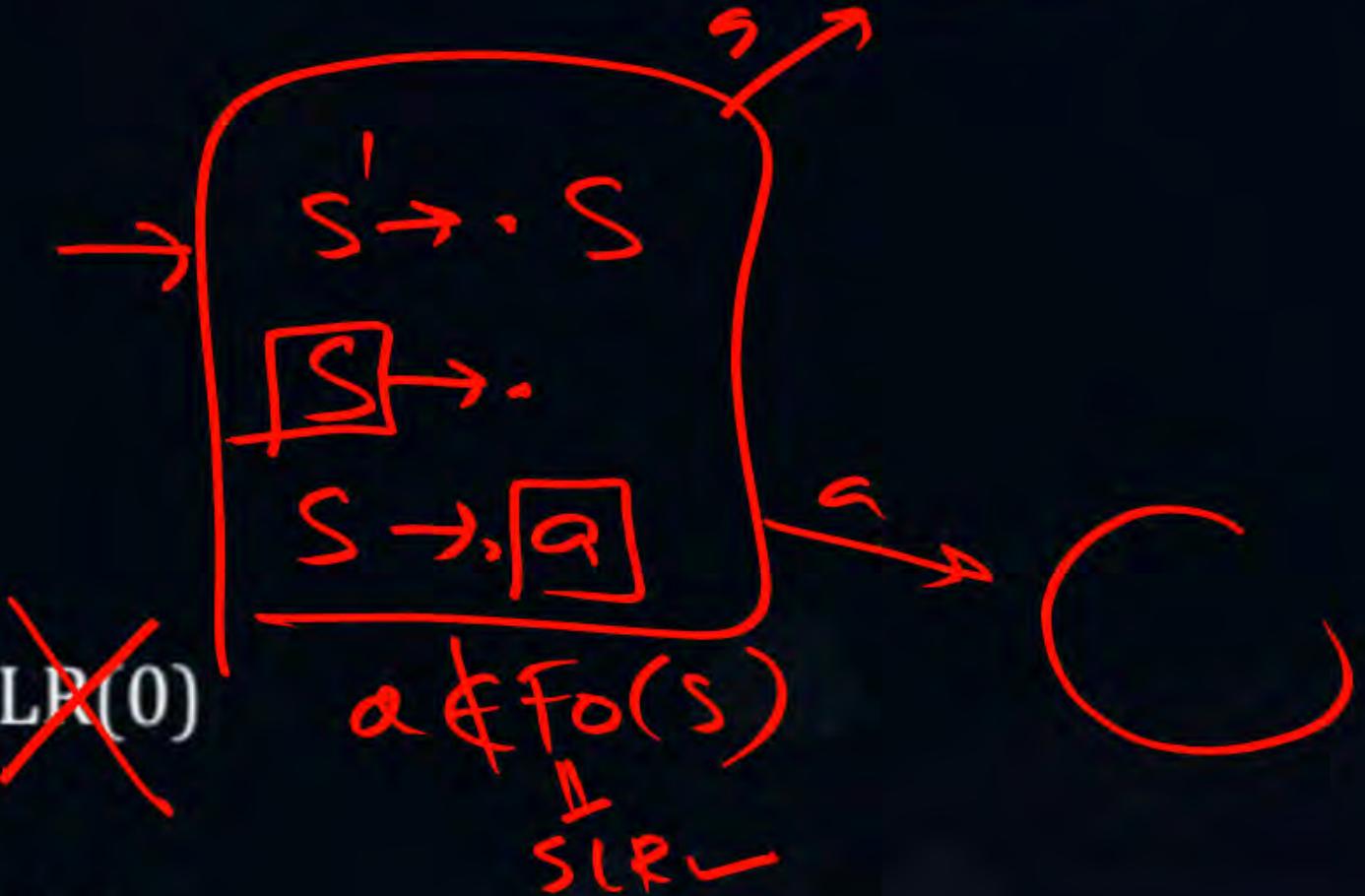
$$S \rightarrow \text{epsilon} \mid a$$

G is _____

A LL(1)

C SLR

B
D CLR



A C D ✓

#Q19. Consider the following grammar:

$$S \rightarrow T Z$$

$$Z \rightarrow Q Z \mid \epsilon$$

$$T \rightarrow Y Q$$

$$Q \rightarrow Y Q \mid \epsilon$$

$$Y \rightarrow (S) \mid \text{id}$$

Number of ~~non-terminals~~ terminals in $\text{First}(Z)$ are A+1 and number of ~~non-terminals~~ terminals in $\text{Follow}(Y)$ are B+1 then the value of A + B is $2+3=5$

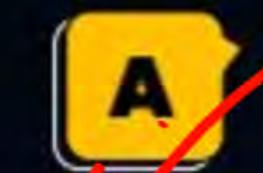
$$\text{First}(Z) = \{\epsilon, (, \text{id}\}$$

$$\text{Follow}(Y) = \{(, \text{id},), \$\}$$

#Q20. Consider the following grammar G:

$$\begin{aligned} S &\rightarrow SS \mid A1 \\ A &\rightarrow \underline{Sb} \mid \underline{1} \end{aligned}$$

Then which of the following is TRUE?



G is ambiguous.



$\text{Follow}(S) = \{a, b\}$

-AD



G is LL(1).



Size of follow of S is 3
 $= \{\$, b, 1\}$

#Q21. Consider the following grammar:

$$S \rightarrow A \mid C$$

$$A \rightarrow t$$

$$C \rightarrow t$$

A \rightsquigarrow C \times a

Which of the following is true?

A

No RR conflict in CLR(1) and LALR (1).

B

No RR conflict in CLR(1) but RR in LALR (1)

C

RR in CLR(1) but not in LALR(1)

D

Both CLR(1) and LALR (1) contains conflicts.

#Q22. Consider the following Grammar G.

G:

$$\begin{array}{l} S \rightarrow Aa \mid Sa \mid d \\ A \rightarrow Ab \mid Sb \mid d \end{array}$$

↑
↑
A_{ML} C_{FCA}

G is _____

A

LL(1)

C

SLR

B

LR(0)

D

CLR

#Q23. Which of the following statement(s) is not true?

- A An LL(1) parser is top down parser.

T

- B Ambiguous grammar **may** be LL(1).

F

- C LL(1) grammar is LR(1)

T

- D LR(1) grammar is LL(1)

F

#Q24. Sum of number of elements in First(S) and Follow(B) for the grammar given below is ____.

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

$$A \rightarrow 0B1$$

$$B \rightarrow 0B \mid 1B \mid \epsilon$$

$$\text{First}(S) = \boxed{\{0, 1\}}$$

$$\text{Follow}(B) = \boxed{\{1\}}$$

$$|\text{First}(S)| + |\text{Follow}(B)| = ?$$

$$= 2 +$$

$$= 3,$$

#Q25. If we merge states in LR(1) parser to form a LALR(1) parser, it ~~may~~  introduce

- A SR conflict
- B RR conflict 
- C No extra conflict
- D Both SR as well as RR.

CLR

 states are merged to get LALR
only RR Conf possible

#Q26. Consider the following grammar:

$$S \rightarrow A$$

$$A \rightarrow B \mid \epsilon$$

$$B \rightarrow \epsilon \mid 0$$

Given grammar is /are possible:

A

SLR(1) but not LR(0)

B

LALR(1) but not SLR(1)

C

CLR(1) but not LALR

D

None of these

#Q27. Consider the following grammar:

$$S \rightarrow A + B$$

$$A \rightarrow A^* b \mid a$$

$$B \rightarrow c - B \mid d$$

Find the correct precedence relation.

A

+ is higher than *

B

* is higher than +

C

- is higher than *

D

None of these

#Q28. Consider the following grammar:

$$S \rightarrow A + B$$

$$A \rightarrow A^* b \mid a$$

$$B \rightarrow c - B \mid d$$

Find the correct precedence relation.

A

+ is right associative

B

* is right associative

C

- is right associative

D

None of these

#Q29. Which of the following having parser is having more power?.

A

LL(1)

B

SLR(1)

C

LALR(1)

D

LR(1)

#Q30. Number of reductions in bottom-up parser is same as _____

A

Number of steps in derivation of a string

B

Number of substitutions in RMD

C

Length of derivation

D 23

Number of terminals in string

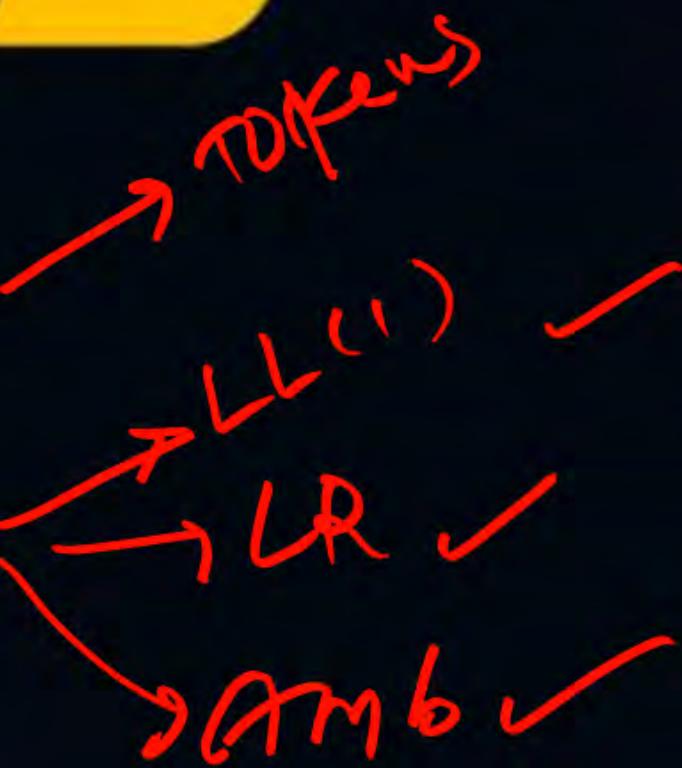


2 mins Summary



Topic

Lexical Analysis



Topic

Syntax Analysis

THANK - YOU

CS & IT ENGINEERING

Compiler Design

Lecture No.- 03

Mallesham Devasane Sir



Recap of Previous Lecture



Topic

Lexical Analysis

Topic

Syntax Analysis

Topics to be Covered



Topic

Syntax Directed Translations

#Q25. If we merge states in LR(1) parser to form a LALR(1) parser, it **may** introduce

- A SR conflict X
- B RR conflict ✓
- C No extra conflict ✓
- D Both SR as well as RR.

#Q26. Consider the following grammar:

$$S \rightarrow A$$

$$A \rightarrow B \mid \epsilon$$

$$B \rightarrow \epsilon \mid 0$$

Amb CFG

Given grammar is ~~not possible~~:

- A** SLR(1) but not LR(0)
- B** LALR(1) but not SLR(1)
- C** CLR(1) but not LALR
- D** None of these

#Q27. Consider the following grammar:

$$S \rightarrow A + B$$

$$A \rightarrow A^* b \mid a$$

$$B \rightarrow c - B \mid d$$

Find the correct precedence relation.

* is higher than +

- " " +

* is Left Associative

- is Right "

A

+ is higher than *

B

* is higher than + ✓

C

- is higher than *

D

None of these

#Q28. Consider the following grammar:

$$S \rightarrow A + B$$

$$A \rightarrow A^* b \mid a$$

$$B \rightarrow c - B \mid d$$

Find the correct precedence relation.

A

+ is right associative

C

- is right associative

B

* is right associative

D

None of these



#Q29. Which of the following ~~having~~ parser is having more power?.

A

LL(1)

C

LALR(1)

B

SLR(1)

D

LR(1)
CLR

#Q30. Number of reductions in bottom-up parser is same as _____

A

Number of steps in derivation of a string ✓

B

Number of substitutions in RMD ✓

C

Length of derivation ✓

D_m

Number of terminals in string X

Semantic Analysis : NAT

#Q31. Consider the following grammar along with translation rules.

$$S \rightarrow S_1 \# T \quad \{S_{.val} = S_1.val * 2\}$$

$$S \rightarrow T \quad \{S_{.val} = T_{.val}\}$$

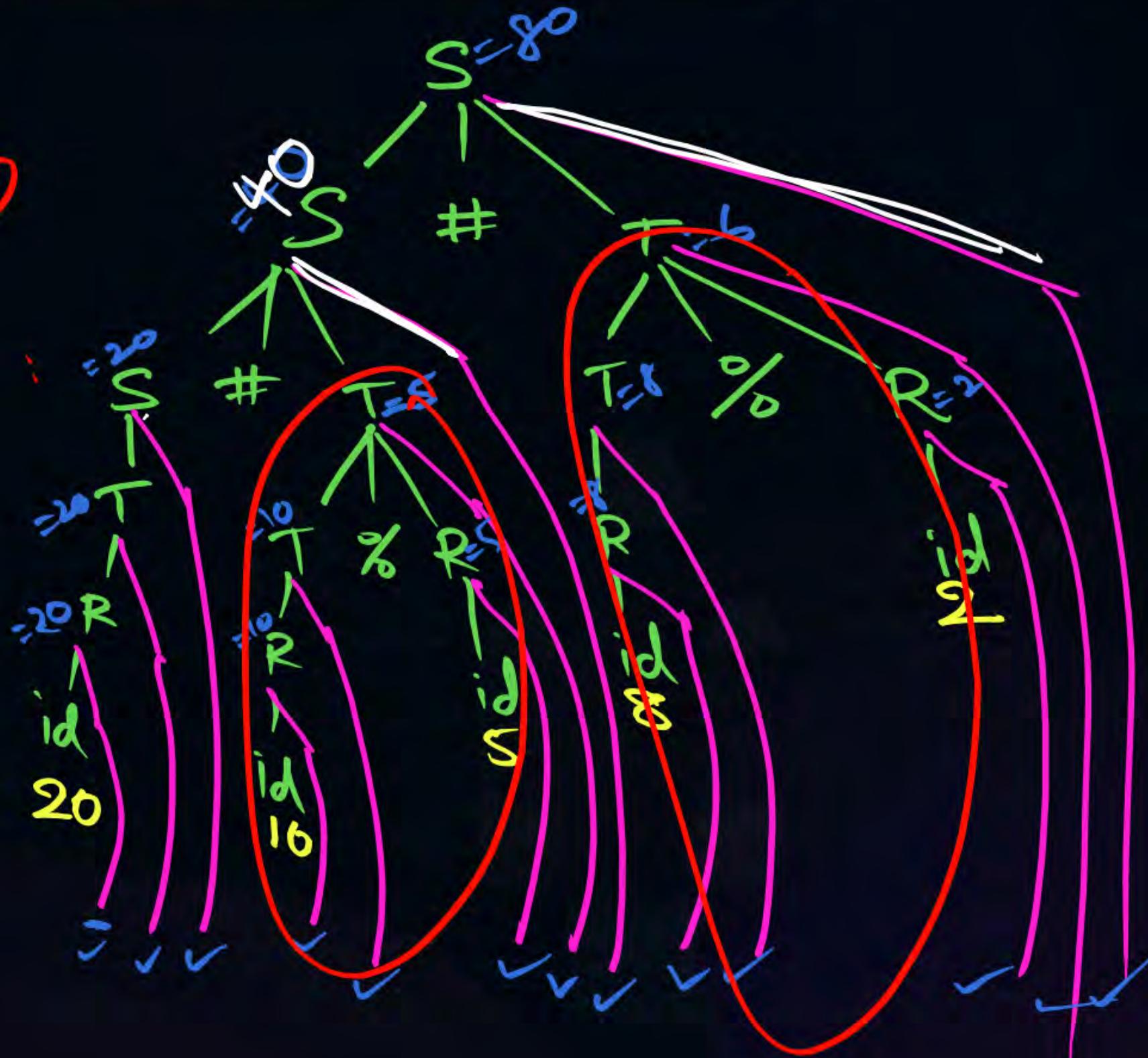
$$T \rightarrow T_1 \% R \quad \{T_{.val} = T_1.val - R_{.val}\}$$

$$T \rightarrow R \quad \{T_{.val} = R_{.val}\}$$

$$R \rightarrow id \quad \{R_{.val} = id.val\}$$

Using this translation scheme, the computed value of $S_{.val}$ for root of the parse tree for the expression $20 \# 10 \% 5 \# 8 \% 2$ is _____.

-80



#Q32. Consider the following two rules.

$$1: A \rightarrow PQ \{ \underbrace{P.i = A.i}_{\text{Inherited}}; \underbrace{Q.i = P.i + 1}_{\text{Inherited}}; \underbrace{A.S = P.i + Q.i}_{\text{synthesized}} \} \Rightarrow L\text{-attributed Def}$$

$$2: A \rightarrow XY \{ \underbrace{X.i = A.i + Y.S}_{\text{Inherited}} \text{ and } \underbrace{Y.i = X.S + A.i}_{\text{Inherited}} \} \Rightarrow \text{Not L-attributed Def}$$

Which one of the following is TRUE?

A

1 is S-attributed

B

2 is S-attributed

C

1 is L-attributed

D

2 is L-attributed

$$A \rightarrow \underline{X} Y \left\{ \begin{array}{l} \xrightarrow{\text{Parent}} X = A + Y \\ \xrightarrow{\text{Right sibling}} Y = X + A \end{array} \right.$$

#Q33. Which one of the following statements is FALSE?

A

Type checking is done before semantic analysis *False*

B

Type checking is done after syntax analysis *True*

C

Checking variable declaration before its use is done before semantic analysis *False*

D

Checking variable declaration before its use is done after syntax analysis *True*

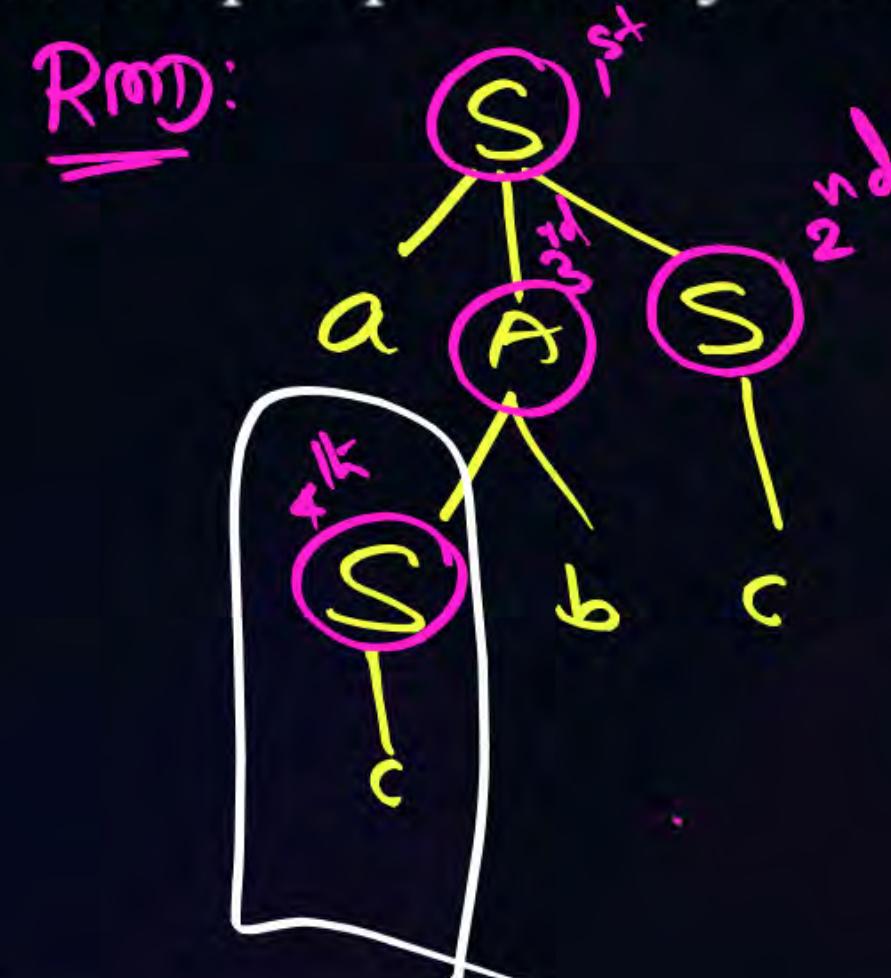
#Q34. Consider the following SDT.

$$S \rightarrow aAS \quad \{print\ 12\}$$

$$S \rightarrow c \quad \{print\ 21\}$$

$$A \rightarrow Sb \quad \{print\ 121\}$$

Find the output printed by a bottom-up parser, for the input $acbc$ is:



acbc

2|1|2|12|12

BUP:

4^{1E} 3^{2D} 2^{3M} 1^{5T}
2| 12| 2| 12

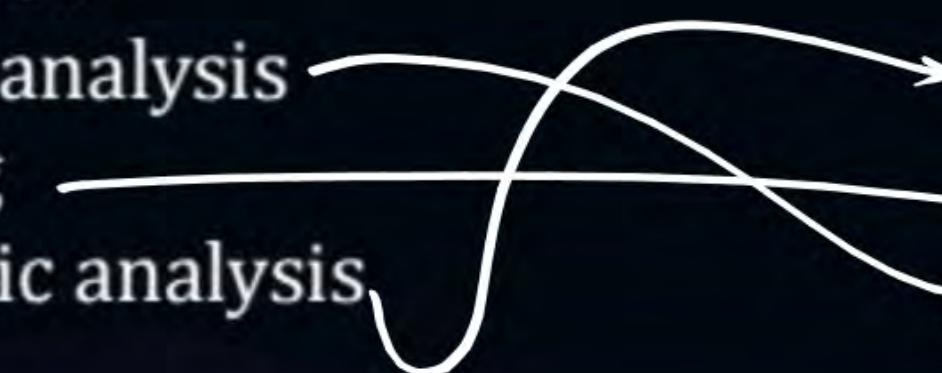
#Q35. Match the following:

List-I

- a. Lexical analysis
- b. Parsing
- c. Semantic analysis

List-II

- 1. Type checking
- 2. Syntax checking
- 3. Token recognizing



A

a-1, b-2, c-3

B

a-3, b-2, c-1

C

a-2, b-3, c-1

D

None of these

#Q36. Consider the following statements

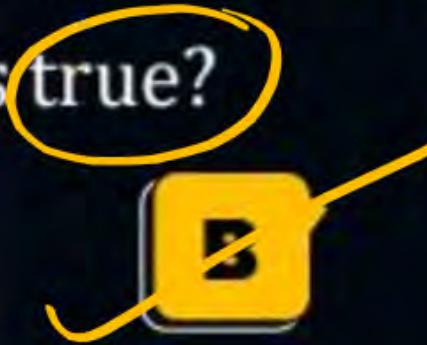
S1: The value at node is computed from the value of the attribute at the children of that node (*Synthesized Attribute*)

S2: The value at node is computed from the value of the attribute at the parent or sibling of that node (*Inherited Attribute*)

Which of the following is true?

A

S1 is inherited



S1 is synthesized

C

S2 is inherited



S2 is synthesized

#Q37. Find E. value for the expression $3 \odot 2 \& 5$ after the evaluation of the following SDT?

- $E \rightarrow E_1 \odot T \quad \{ E.Val = E1Val * T.Val \}$
- $E \rightarrow T \quad \{ E.Val = T.Val \}$
- $T \rightarrow T1 \& F \quad \{ T.Val = T1Val + F.Val \}$
- $T \rightarrow F \quad \{ T.Val = F.Val \}$
- $F \rightarrow \text{num} \quad \{ F.Val = \text{num.Val} \}$

#Q38. Find E. value for the expression $3 - 2 + 5$ after the evaluation of the following SDT?

- $E \rightarrow E_1 - T \quad \{ E.Val = E1Val + T.Val \}$
- $E \rightarrow T \quad \{ E.Val = T.Val \}$
- $T \rightarrow T1 + F \quad \{ T.Val = T1Val - F.Val \}$
- $T \rightarrow F \quad \{ T.Val = F.Val \}$
- $F \rightarrow \text{num} \quad \{ F.Val = \text{num.Val} \}$

#Q39. Which of the following rule appears in L-attributed?

A

$A \rightarrow B \{A.x = B.val\}$

B

$A \rightarrow B \{B.x = A.val\}$

C

$A \rightarrow \{A.x = B.val\} B$

D

$A \rightarrow \{B.x = A.val\} B$

#Q40. Which of the following rule appears in S-attributed?

A
$$A \rightarrow B \{A.x = B.val\}$$
B
$$A \rightarrow B \{B.x = A.val\}$$
C
$$A \rightarrow \{A.x = B.val\} B$$
D
$$A \rightarrow \{B.x = A.val\} B$$



2 mins Summary



Topic

Lexical Analysis & Syntax Analysis

Topic

Syntax Directed Translations

THANK - YOU

CS & IT ENGINEERING

Compiler Design

Lecture No.- 04

Mallesham Devasane Sir



Recap of Previous Lecture

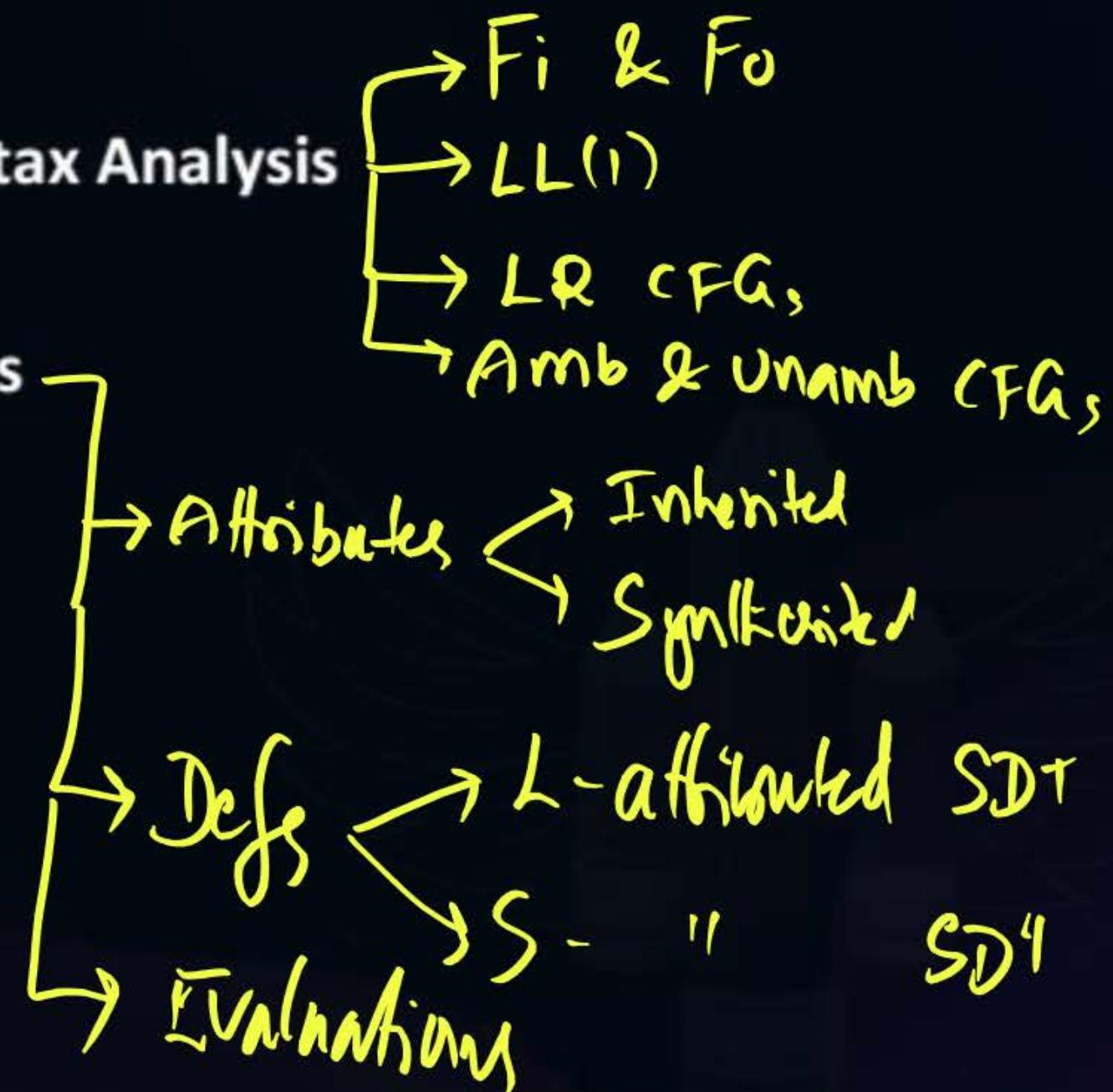


Topic

Topic

Syntax Analysis

SDTs



Topics to be Covered



Topic

Intermediate Code

#Q37. Find E. value for the expression $3 \odot 2 & 5$ after the evaluation of the following SDT?

$$E \rightarrow E_1 \odot T \quad \{ E.Val = E1Val * T.Val \}$$

$$E \rightarrow T \quad \{ E.Val = T.Val \}$$

$$T \rightarrow T1 \& F \quad \{ T.Val = T1Val + F.Val \}$$

$$T \rightarrow F \quad \{ T.Val = F.Val \}$$

$$F \rightarrow \text{num} \quad \{ F.Val = \text{num.Val} \}$$

* +
7

// 2 \\ //

#Q38. Find E. value for the expression $3 - \cancel{2 + 5}$ after the evaluation of the following SDT?

$E \rightarrow E_1 - T \quad \{ E.Val = E1Val + T.Val \}$

$E \rightarrow T \quad \{ E.Val = T.Val \}$

$T \rightarrow T1 + F \quad \{ T.Val = T1Val - F.Val \}$

$T \rightarrow F \quad \{ T.Val = F.Val \}$

$F \rightarrow num \quad \{ F.Val = num.Val \}$

$= 0 //$

#Q39. Which of the following rule appears in L-attributed?

- A $A \rightarrow B \{A.x = B.val\}$ ✓
- B $A \rightarrow B \{B.x = A.val\}$ ✓
- C $A \rightarrow \{A.x = B.val\} B$ ✓
- D $A \rightarrow \{B.x = A.val\} B$ ✓

#Q40. Which of the following rule appears in S-attributed?

A

$A \rightarrow B \{A.x = B.val\}$

C

$A \rightarrow \{A.x = B.val\} B$

B

$A \rightarrow B \{B.x = A.val\}$

D

$A \rightarrow \{B.x = A.val\} B$

IC / IR



Intermediate Code : NAT

#Q41. Consider the following expression.

$$x = (a + b) * (a + b) * (a + b)$$

Find the minimum number of variables in equivalent 3AC.

$$a = a + b$$

$$b = a * a$$

$$a = b * a$$

Three Addre^ys code

Intermediate Code : NAT

#Q42. Consider the following expression.

$$x = (a + b) * (a + b) * (a + b)$$

Find the minimum number of nodes in DAG.



6

Intermediate Code : NAT

#Q43. Consider the following expression.

$$x = a + b * a + b * a + b$$

t_1 t_1

a b

Find the minimum number of variables in 3AC.

,"3"

$$\begin{aligned}t_1 &= b * a \\a &= a + t_1 \\b &= t_1 + b \\a &= a + b\end{aligned}$$

Intermediate Code : NAT

#Q44. Consider the following expression.

$$x = a * a + b * a$$

= 2

Find the minimum number of ~~nodes~~ ^{variables} in 3AC.

$$x = \underbrace{(a * a)}_{a} + \underbrace{(b * a)}_{b}$$

$$b = b * a$$

$$q = a * q$$

$$q = q + b$$

Intermediate Code : NAT

#Q45. Consider the following expression.

$$x = a + a + a + a + a$$

$$\quad \quad \quad b \\ b \\ b$$

Find the minimum number of variables in 3AC.

$$b = a + a$$

$$b = b + b$$

$$a = b + a$$

Intermediate Code : NAT

#Q46. Consider the following expression.

$$x = \underbrace{a + a}_{b} + \underbrace{a + a}_{b} + a$$

Find the minimum number of variables in SSA code.

$$\begin{array}{l} b = a + a \\ b = b + b \\ a = b + a \end{array}$$

3AC

$$\begin{array}{ll} b = a + a & b \\ b_1 = b + b & b_1 \\ a_1 = b_1 + a & a_1 \end{array}$$

a, b, a₁, b₁

Intermediate Code : NAT

#Q47. Consider the following expression.

$$x = \boxed{a + a + a + a} + a$$

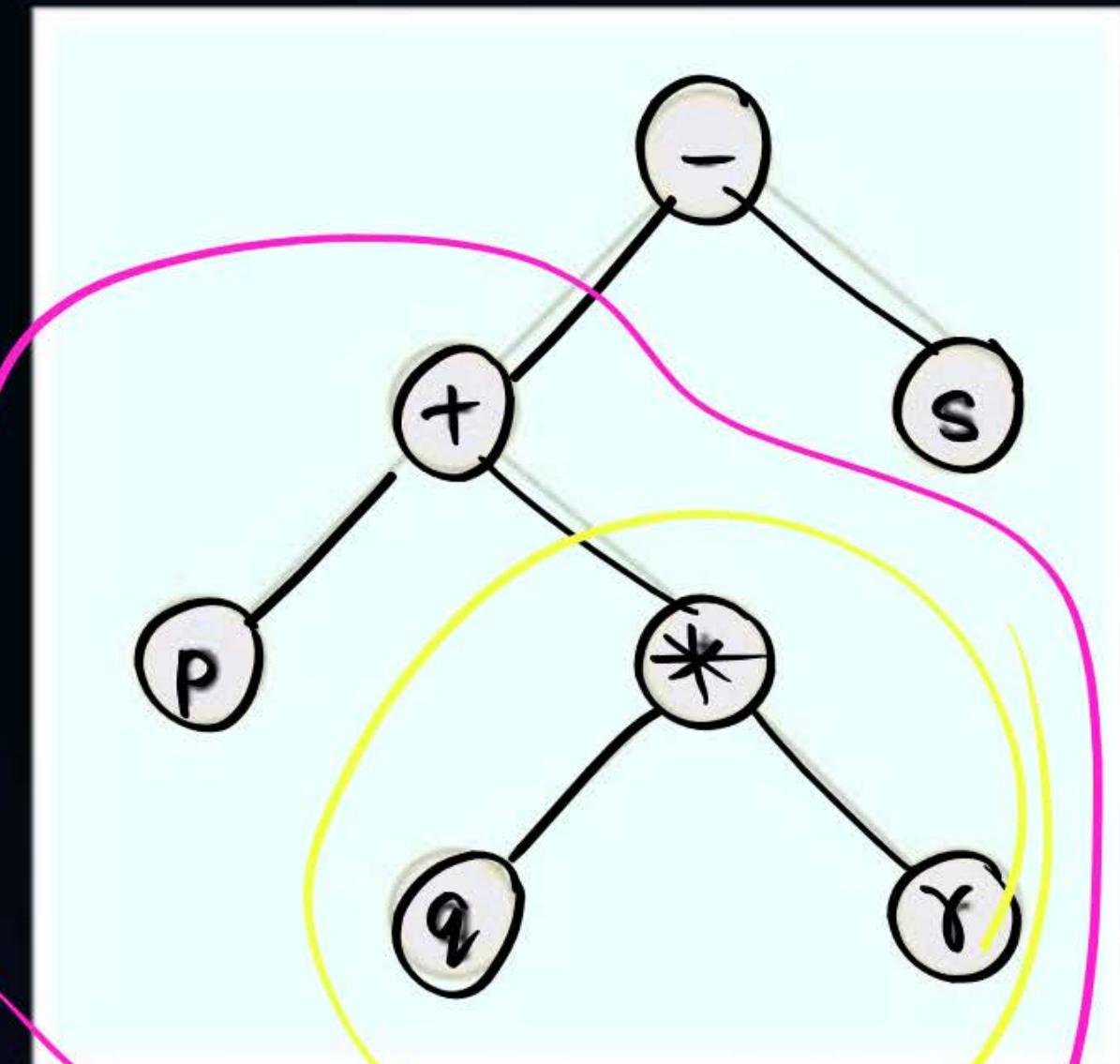
Find the minimum number of nodes in DAG.



Intermediate Code : MCQ

#Q48. Consider the following syntax tree.

- A $p + ((q * r) - s)$
- B $(p + (q * r)) - s$
- C $(p + q)^*(r - s)$
- D None of these



Intermediate Code : NAT

#Q49. Consider the following 3AC.

$$\begin{array}{l} a = a + b \\ a = a * c \\ a = a + b \end{array}$$



$$\begin{array}{l} a = (a * 1) + b \\ - (a + b) * c + b \end{array}$$

$$(a+b) * c + b$$

How many minimum number of variables in equivalent 3AC?

$$a = a + b$$

- 3 //

$$a = a * c$$

$$a = a + b$$

Intermediate Code : MCQ

#Q50. Consider the following 3AC.

$$\begin{array}{l} a=2 \\ b=c \\ d=a*b \\ e=x \\ f=e-d \end{array} \quad \left| \begin{array}{l} f = x - d = x - (a*b) = x - (2*c) \end{array} \right.$$

Which of the following expression is equivalent to above 3AC?

A

$$x - (a * b)$$

C

$$x - (a * c)$$

B

$$2 - (a * b)$$

D

$$x - (2 * c)$$

Intermediate Code : NAT

#Q51. Consider the following code.

$$T1 = y - z$$

$$T2 = x * T1$$

$$T3 = x + T2$$

$$T4 = T1 * e$$

$$\begin{aligned} T5 &= T3 + T4 \\ &= (x + T2) + (T1 * e) \\ &= (x + (x * T1)) + ((y - z) * e) \end{aligned}$$

How many edges in DAG for the above 3AC?

$$\begin{aligned} &= (x + (x * (y - z))) + (((y - z) * e)) \\ &= 10 \text{ edges} \end{aligned}$$

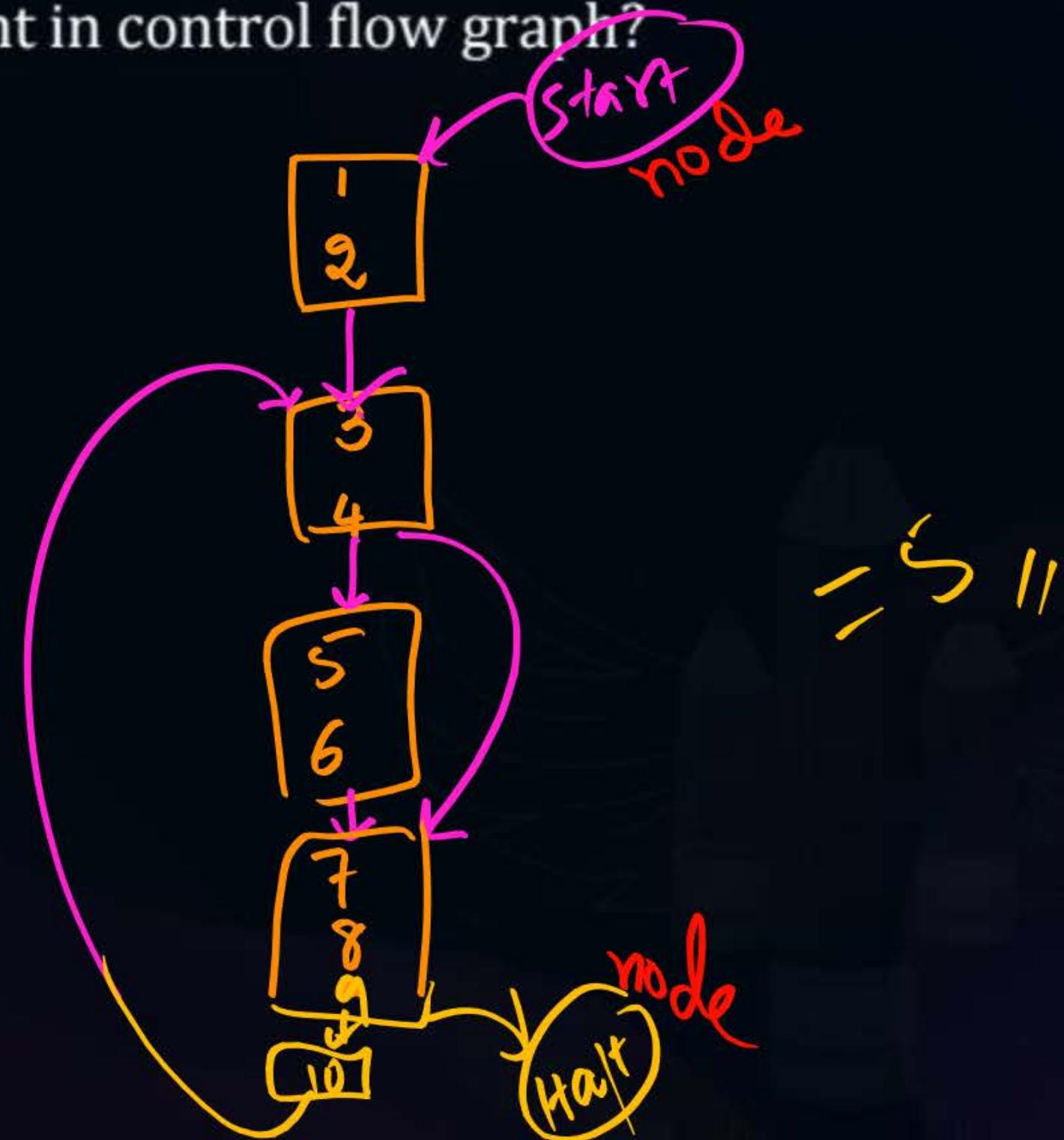


Intermediate Code : NAT

#Q52. How many basic blocks present in control flow graph?

A control flow graph illustrating the execution flow of a pseudocode program. The nodes are labeled with line numbers from 1 to 14. The edges represent the flow of control between statements. A pink oval highlights the loop body starting at L1. A red arrow points to the exit condition of the loop at line 10.

```
graph TD; 1[A = 4]; 2[t1 = A * B]; 3[L1: t2 = t1 / C]; 4;if_t2_W_goto_L2; 5[M = t1 * k]; 6[t3 = M + I]; 7[H = I]; 8[M = t3 - H]; 9;if_t3_0_goto_L3; 10[goto L1]; 11[L3: halt];
```

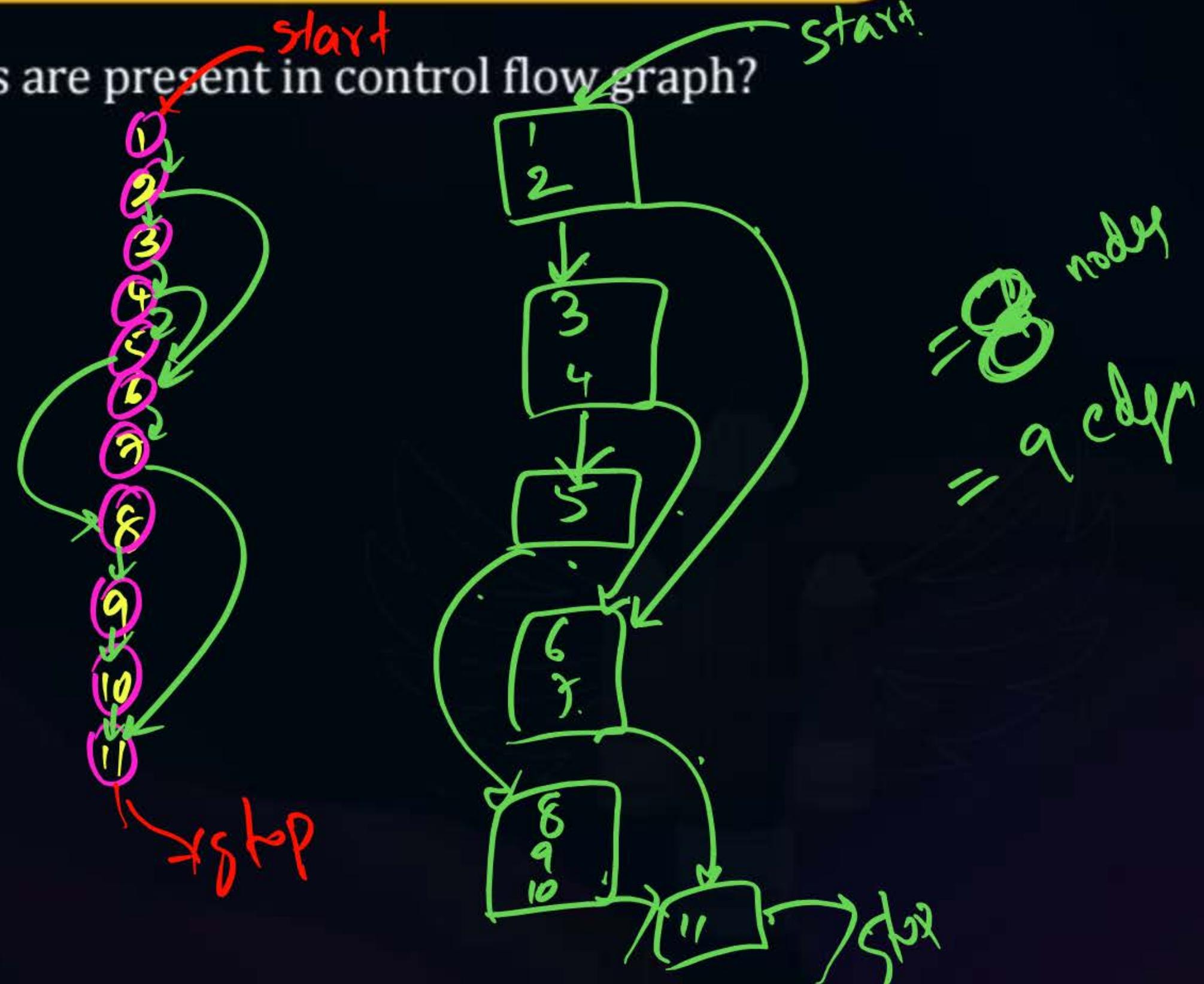


Intermediate Code : NAT

#Q53. How many nodes and edges are present in control flow graph?

```

1 a=10
2 if a<b goto L2
3 goto L4
L4:
4 if c<d goto L2
5 goto L3
L2:
6 v=0
7 goto L1
L3:
8 t1=t2+1
9 t3=B[t1]
10 a=t3
L1:
11 s=1
    
```



Intermediate Code : NAT

#Q54. How many nodes ~~and edges~~ are present in control flow graph?

- 1) $i = 1$
- 2) $j = 1$
- 3) $t1 = 10 * i$
- 4) $t2 = t1 + j$
- 5) $t3 = 8 * t2$
- 6) $t4 = t3 - 88$
- 7) $a[t4] = 0.0$
- 8) $j = j + 1$
- 9) $\text{if } j \leq 10 \text{ goto (3)}$
- 10) $i = i + 1$
- 11) $\text{if } i \leq 10 \text{ goto (2)}$
- 12) $i = 1$
- 13) $t5 = i - 1$
- 14) $t6 = 88 * t5$
- 15) $a[t6] = 1.0$
- 16) $i = i + 1$
- 17) $\text{if } i \leq 10 \text{ goto (13)}$

Intermediate Code : NAT

#Q55. How many nodes ~~and edges~~ are present in control flow graph?

```
w = 0;  
x = x + y;  
if( x > z ) {  
    y = x;  
    x++;  
} else {  
    y = z;  
    z++;  
}  
w = x + z;
```



2 mins Summary



Topic

SDTs

Topic

Intermediate Code

THANK - YOU

CS & IT ENGINEERING

Compiler Design

Lecture No.- 05

Mallesham Devasane Sir



Recap of Previous Lecture



Topic

SDTs

Topic

Intermediate Code

Topics to be Covered



Topic

Code Optimization

Intermediate Code : NAT

#Q52. How many basic blocks present in control flow graph?

```
A = 4
t1 = A * B
L1: t2 = t1 / C
    if t2 < W goto L2
    M = t1 * k
    t3 = M + I
L2: H = I
    M = t3 - H
    if t3 ≥ 0 goto L3
    goto L1
L3: halt
```

= 5

Intermediate Code : NAT

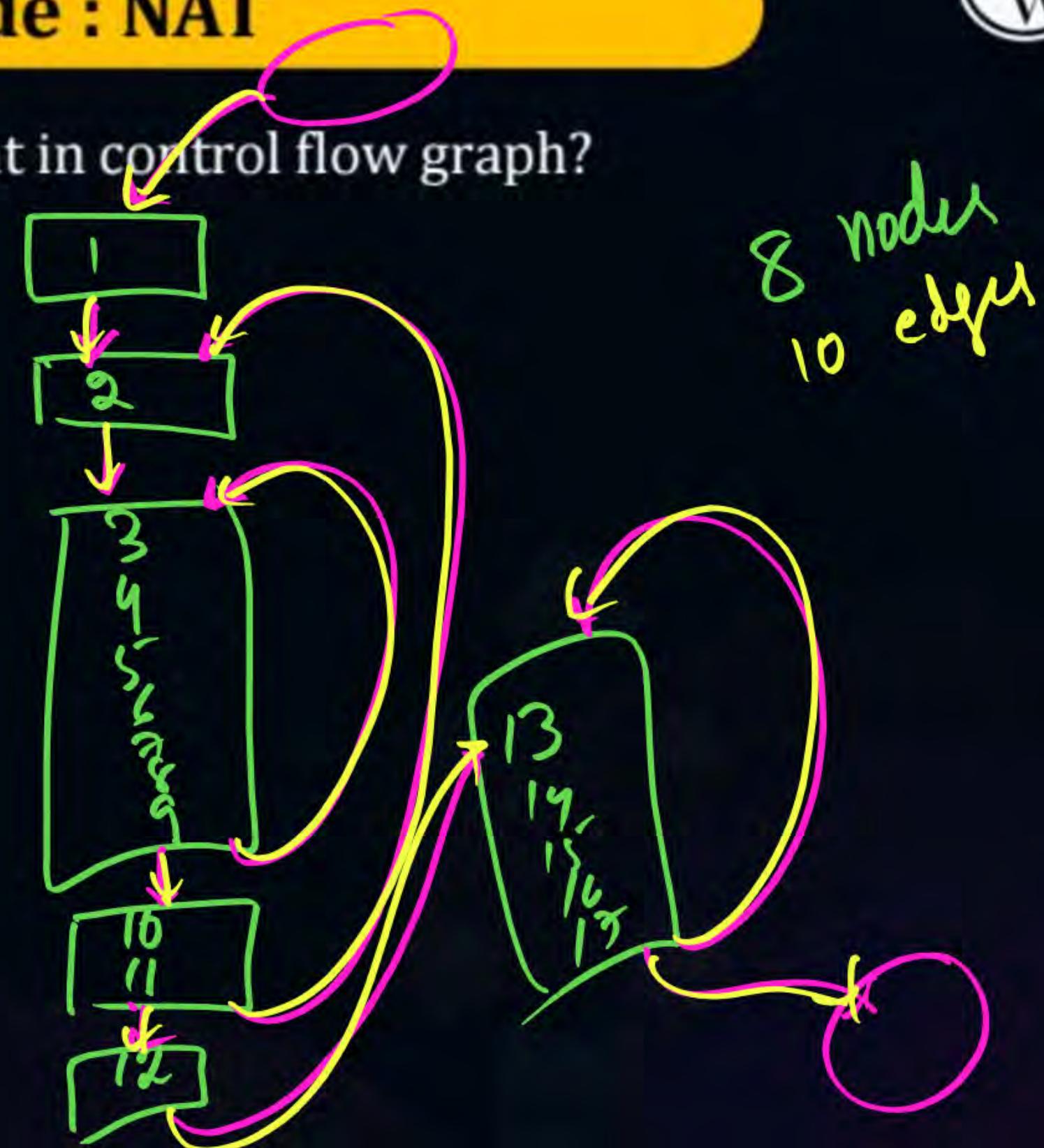
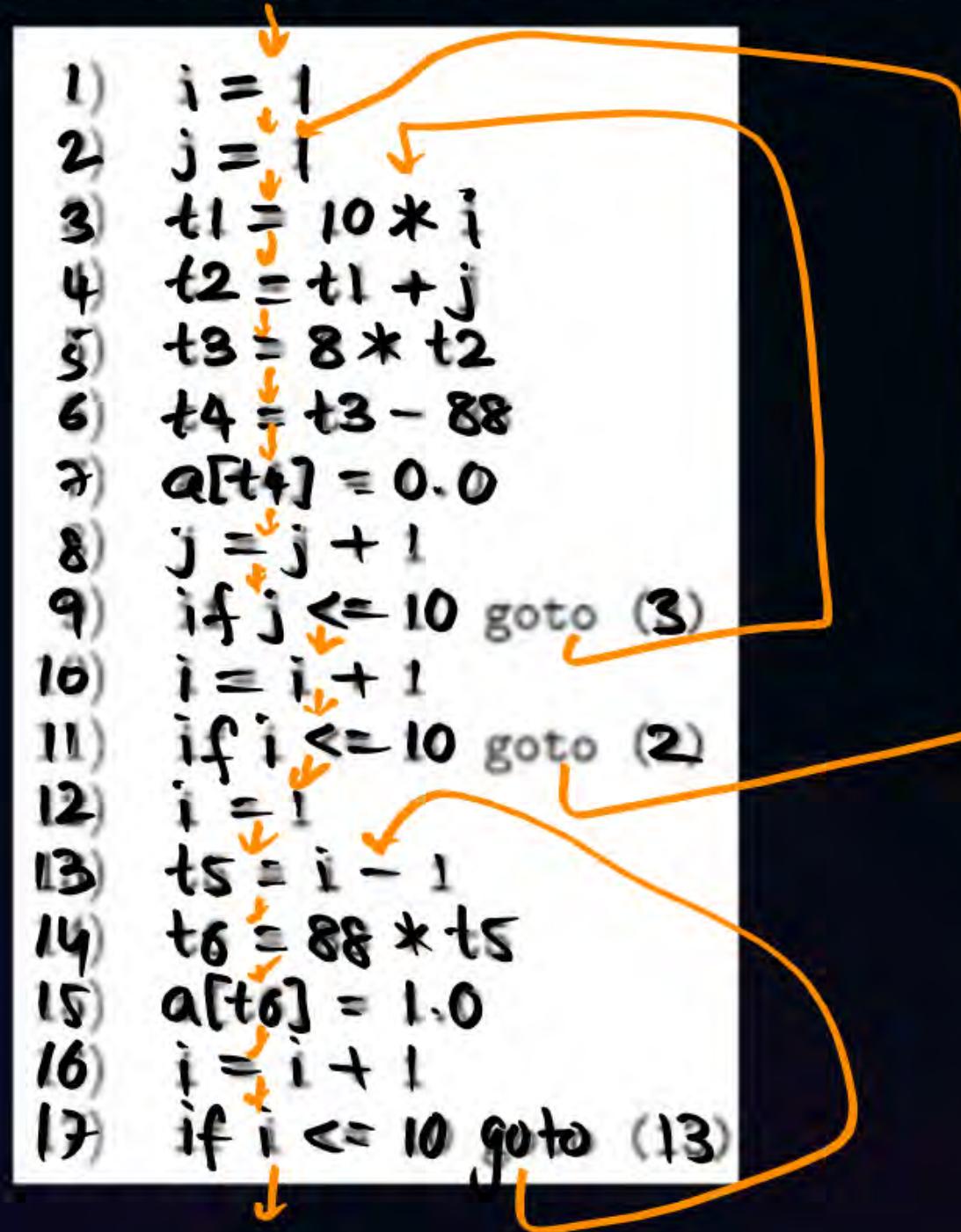
#Q53. How many nodes and edges are present in control flow graph?

```
a=10
if a<b goto L2
goto L4
L4:
if c<d goto L2
goto L3
L2:
v=0
goto L1
L3:
t1=t2+1
t3=B[t1]
a=t3
L1:
s=1
```

1 2 3 4 5 6 7 8 9

Intermediate Code : NAT

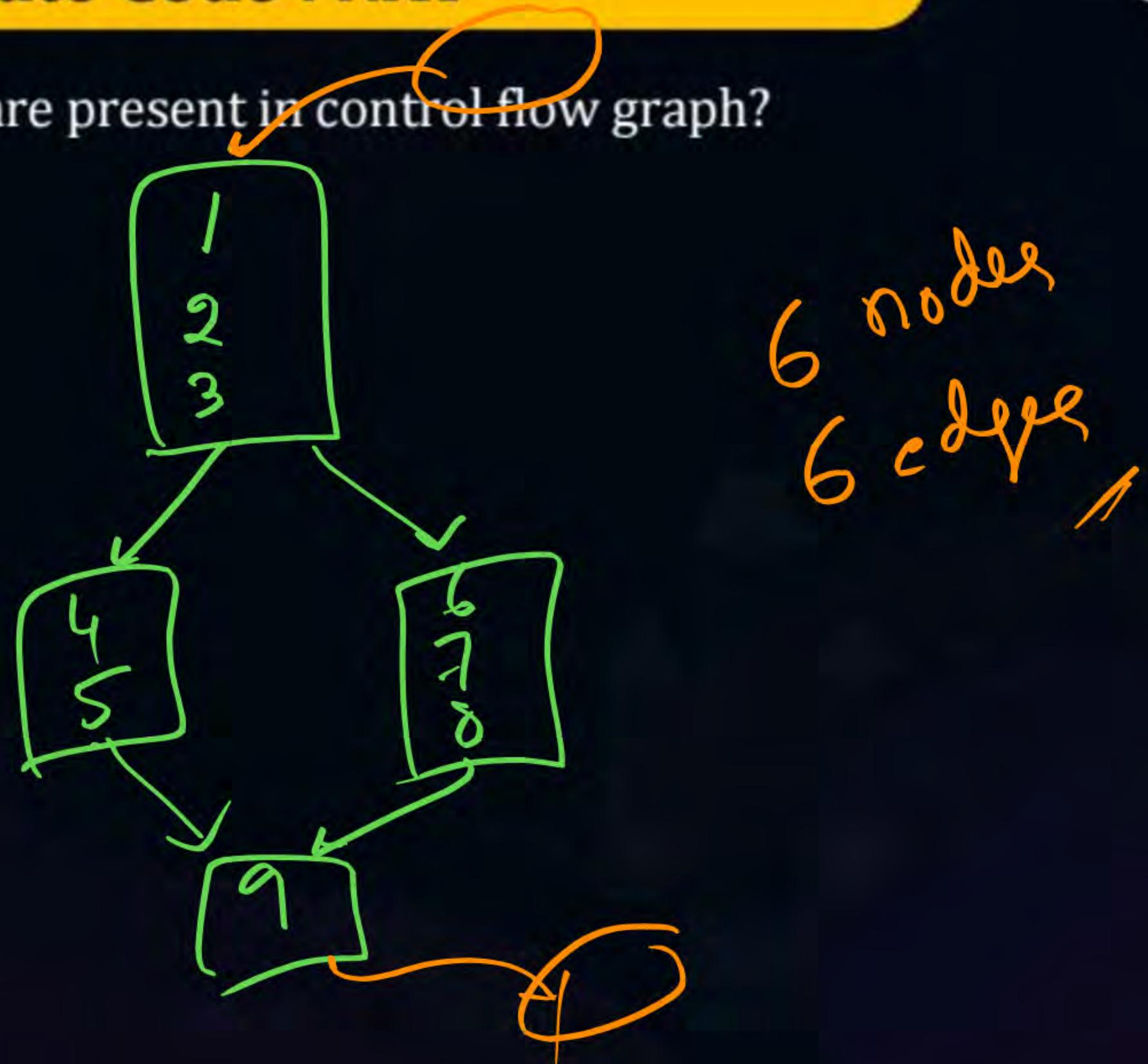
#Q54. How many nodes and edges are present in control flow graph?



Intermediate Code : NAT

#Q55. How many nodes and edges are present in control flow graph?

```
1   w = 0;  
2   x = x + y;  
3   if( x > z ) {  
4       y = x;  
5       x++;  
6   } else {  
7       y = z;  
8       z++;  
9   }  
10  w = x + z;
```



Code Optimization : NAT

#Q56. How many live variables at statement 3?

1. $x = a + b$
2. $y = x + c$
3. $z = z * a$
4. $x = y + z$

z, a, y



// 3 //

S_j(3)

S_j(3)

x is live at s_i

iff

R I) s_j reads x

R II) $s_i \xrightarrow{\text{palk}} s_j$

NW III) No write In between s_i & s_j
(before s_j)

Code Optimization : NAT

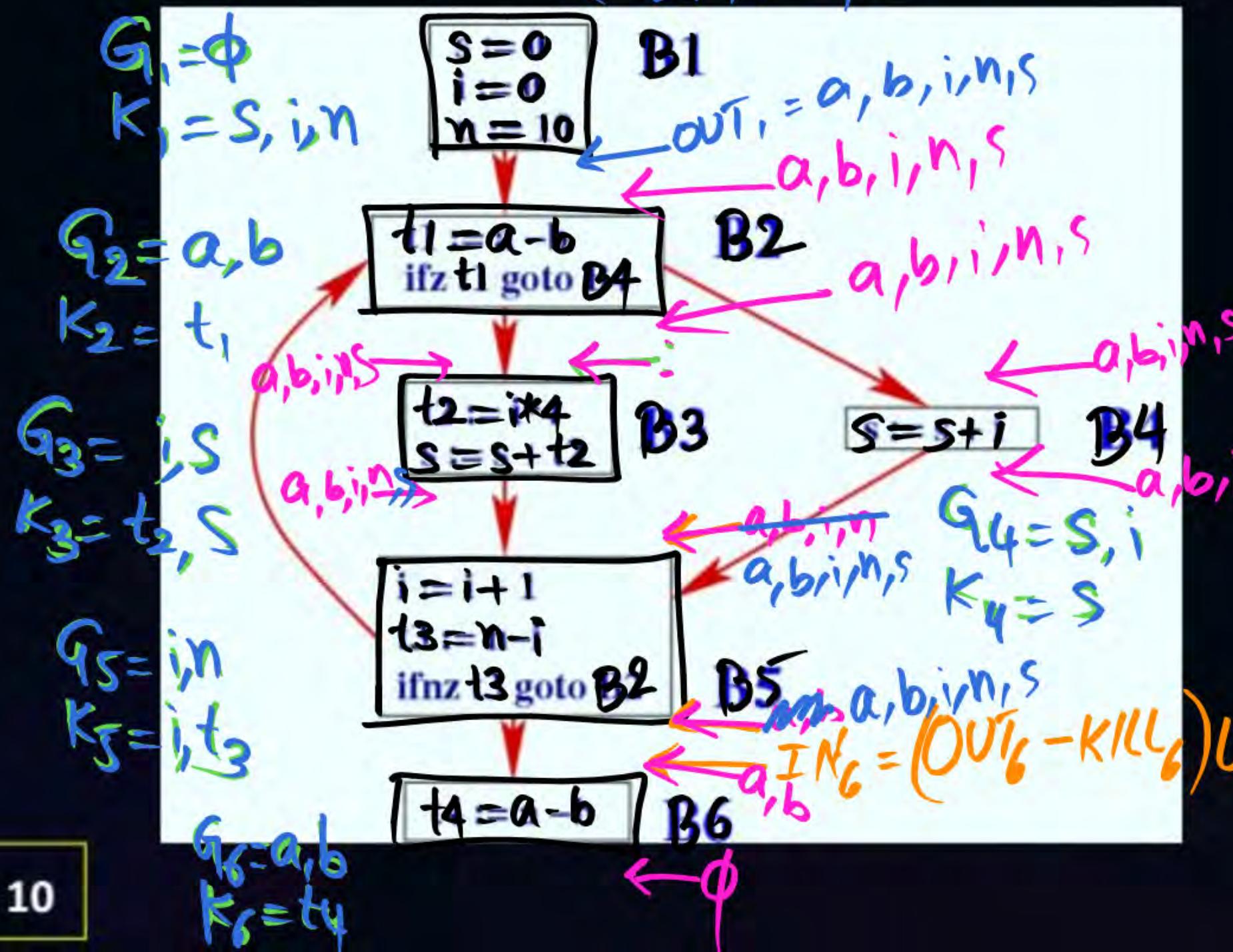
#Q57. How many live variables at statement 4?

1. $x = a + b$
2. $y = x + c$
3. $z = z * a$
4. $x = \cancel{y} + \cancel{z}$ ↪ \varnothing, \emptyset

= 2

Code Optimization : NAT

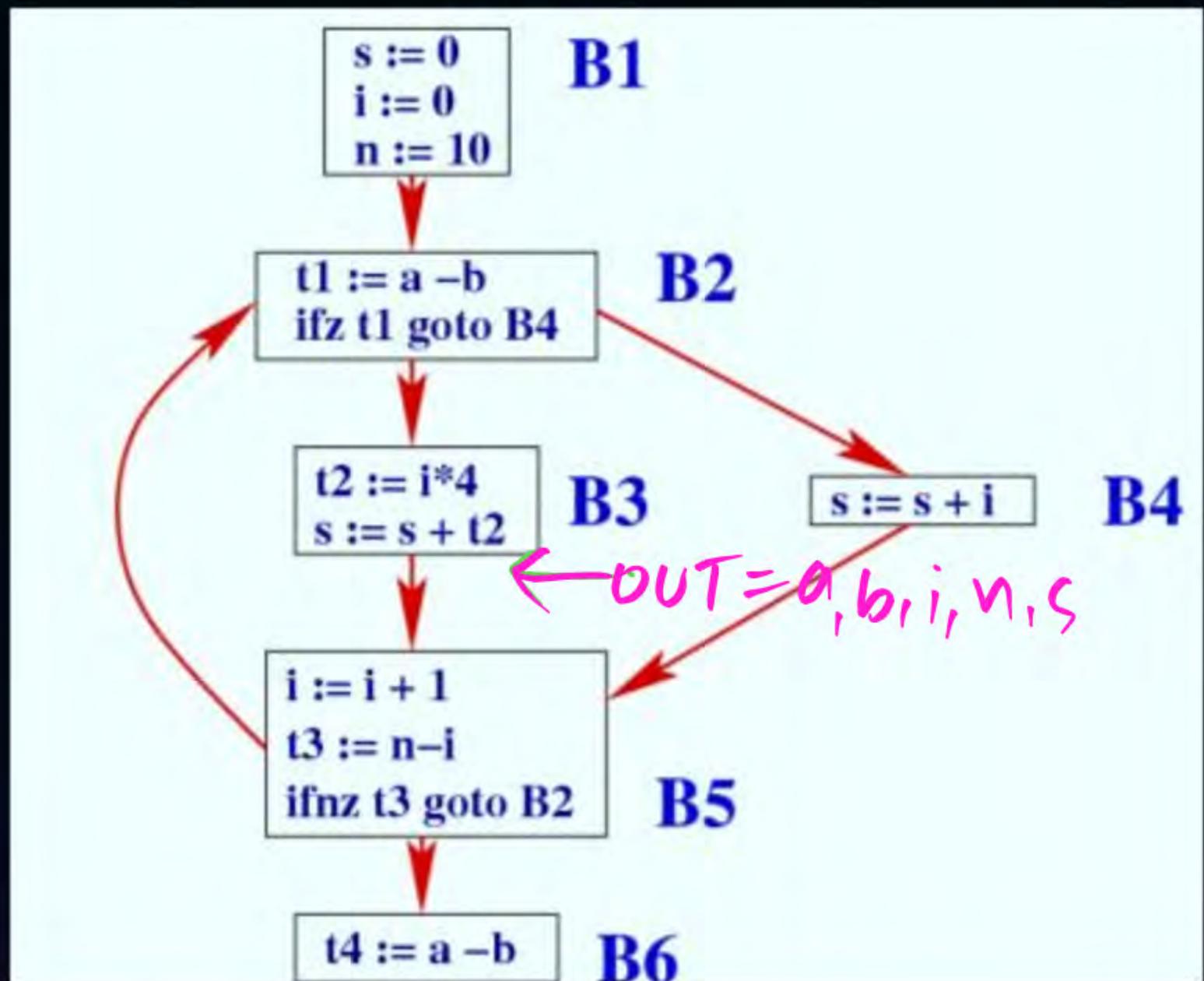
#Q58. Find the size of IN set for Basic block 3.



BB	G	\leftarrow	\leftarrow	IN	OUT
1	ϕ			s, i, n	a, b
2	a, b	t_1		a, b, i, n, s	a, b, i, n, s
3	i, s	t_2, s		a, b, i, n, s	a, b, i, n, s
4	s, i			a, b, i, n, s	a, b, i, n, s
5	i, n	i, t_3		a, b, i, n	a, b
6	a, b	t_4			ϕ

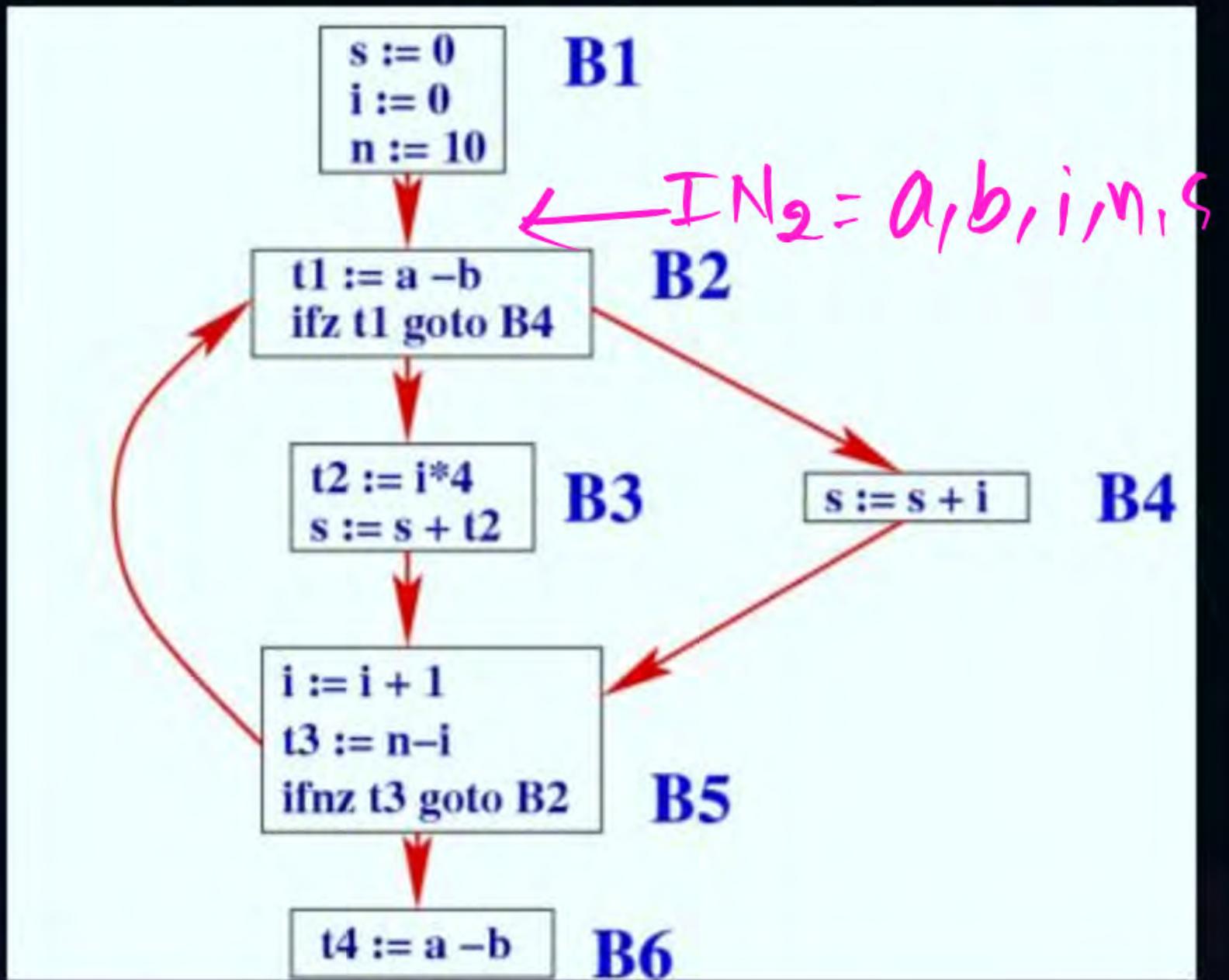
Code Optimization : NAT

#Q59. Find the size of OUT set for Basic block 3. 



Code Optimization : NAT

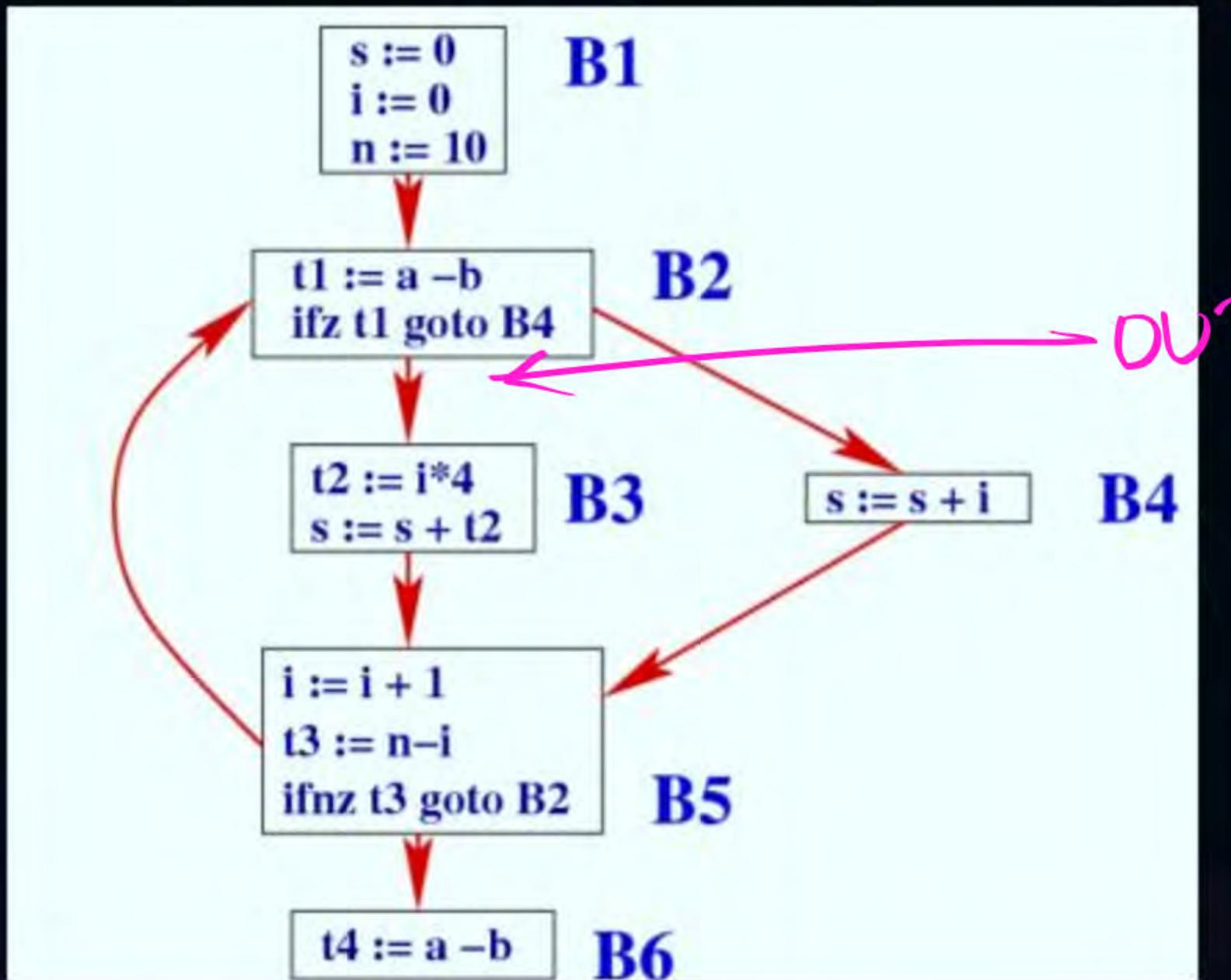
#Q60. Find the size of IN set for Basic block 2. \Rightarrow



Code Optimization : NAT

#Q61. Find the size of OUT set for Basic block 2.

IS



Code Optimization : MSQ

#Q62. Which of the following code optimization possible on below code?

$$\left. \begin{array}{l} x = 2 \\ y = x * a \\ z = x + 5 \end{array} \right\} \Rightarrow \left. \begin{array}{l} x = 2 \\ y = 2 * a \\ z = 2 + 5 \end{array} \right\} \Rightarrow \boxed{\begin{array}{l} x = 2 \\ y = 2 * a \\ z = 7 \end{array}} \Rightarrow y = a \ll 1$$



Copy propagation



Constant folding



Strength reduction



Loop Merging

Code Optimization : MSQ

#Q63. Which of the following code optimization possible on below code?

```
while(x > 0)
{
    y = a * b; invariant
    z = c + x--;
}
```

A Code Motion

C Strength reduction

B Constant folding

D Loop Merging

Code Optimization : MSQ

#Q64. Which of the following code optimization possible on below code?

```
while(x > 0)
{
    y = y + x * 1;   → y = y + x;
    z = z + x + 0;   ↳ z = z + x;
    x=x-1
}
```



Code Motion



Strength reduction



Constant folding



Algebraic simplification

#Q65. Activation record consists of ____.

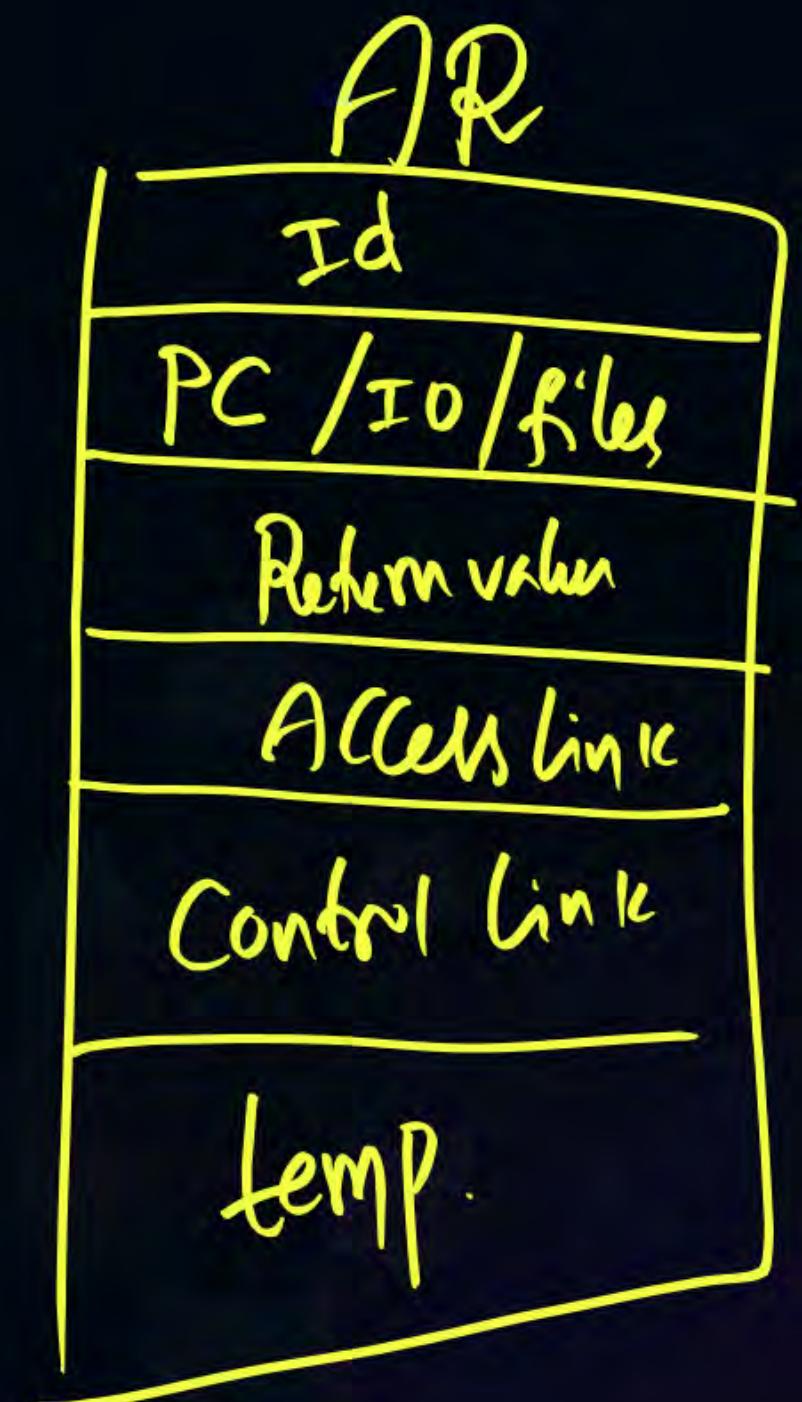
A Access link

C Control link

B Active link

D Passive link

AC



#Q66. With respect to compiler optimization, which of the following represents the strength reduction?

A

Replace $128 * P$ by $P \ll 7$.

Costlier

Cheap



B

Replace $80 + 0$ by 0

Invalid



C

Replace $P \ll 5$ by $P \times 32$

Cheaper

Costlier



D

Replace $1 * P$ by P

Costlier

Cheaper



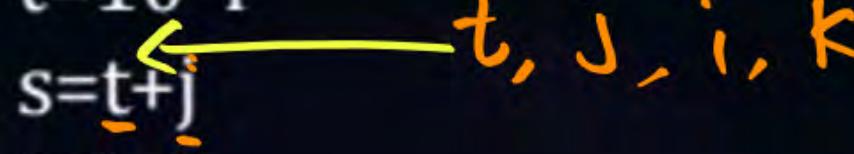
#Q67. Consider the following statements below:

- I. Control stack keeps track of live procedure activations.
- II. Activation records can be managed with the help of stack.
- III. Dangling reference is a reference to a storage that has been deallocated.

The number of incorrect statements is/are ____.

10

#Q68. Find number of live variables at statement 3.

1. i=1
2. t=10*i
3. s=t+j 
4. j=j+1
5. if j< 10 goto 3
6. i=i+1
7. if k<10 goto 2
8. i=1
9. j=i+1

= 4

#Q69. Find number of live variables at statement 5.

1. i=1
2. t=10*i
3. s=t+j
4. j=j+1
5. if j < 10 goto 3
6. i=i+1
7. if k < 10 goto 2
8. i=1
9. j=i+1

j, i, k, t

#Q70. Find number of live variables at statement 7.

1. i=1
2. t=10*i
3. s=t+j
4. j=j+1
5. if j < 10 goto 3
6. i=i+1
7. if k < 10 goto 2
8. i=1
9. j=j+1

; 3



2 mins Summary



Topic

Code Optimization



THANK - YOU