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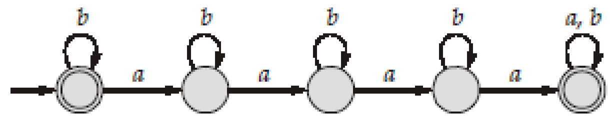
MULTIPLE SUBJECT : THEORY OF COMPUTATION + COMPILER DESIGN (GATE - 2019) - REPORTS

OVERALL ANALYSIS | COMPARISON REPORT | SOLUTION REPORT

ALL(33) | CORRECT(0) | INCORRECT(0) | SKIPPED(33)

Q. 1

Let M be a DFA given below:



Let L(M) be the language generated by the above DFA. Then the complement of L(M) is

(a) $\{w \mid n_a(w) = 2, w \in (a, b)^*\}$

(b) $\{w \mid n_a(w) \le 3, w \in (a, b)^*\}$

(c) $\{w \mid n_a(w) \ge 3, w \in (a, b)^*\}$

(d) $\{w \mid n_a(w) \ge 1, w \in (a, b)^*\} \cap \{w \mid n_a(w) \le 3, w \in (a, b)^*\}$

[Note: $n_a(w)$ indicates number of a's in w]

Have any Doubt ?

A
a

B
b

C
c

D
d

Correct Option

Solution :
(d)

$$\begin{aligned} L(M) &= \{w \mid n_a(w) = 0 \text{ or } , n_a(w) \ge 4\} \\ \overline{L(M)} &\equiv L(\bar{M}) = \{w \mid 1 \le n_a(w) \le 3\} \\ &\equiv \{w \mid n_a(w) \ge 1\} \cap \{w \mid n_a(w) \le 3\} \end{aligned}$$

QUESTION ANALYTICS

Q. 2

Consider the language L_1 and L_2:

$L_1 = \{ww \mid w \in (a, b)^*\}$

$L_2 = \overline{L_1}$

Choose the most appropriate option (strongest answer)

Have any Doubt ?

A
L_1 is CSL, L_2 is CSL

B
L_1 is CSL, L_2 is CFL

Correct Option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there exists a CFG for it.

$S \rightarrow A \mid B \mid AB \mid BA$

$A \rightarrow a \mid aAa \mid aAb \mid bAb \mid bAa$

$B \rightarrow b \mid aBa \mid aBb \mid bBb \mid bBa$

C

L_1 is CFL, L_2 is CSL

D

L_1 is CFL, L_2 is CFL

QUESTION ANALYTICS

Q. 3

Consider the grammar defined by the following production rules with 2 operators + and −:

$A \rightarrow A + B \mid C$

$B \rightarrow B - C$

$C \rightarrow a$

Which of the following is true with respect to operators?

Have any Doubt ?

A

'+' is left association while '−' is right associative

B

'−' is left associative and '+' is right associative

C

Both are left associative

Correct Option

Solution :

(c)

Both '+' and '−' are left associative.

D

None of the above

QUESTION ANALYTICS

Q. 4

Let RE, REC and NOT RE denote the set of all recursively enumerable sets, recursive languages and not recursively enumerable languages respectively. Consider the following statements.

S_1 : The complement of any Non REC language is Non REC.

S_2 : The complement of any REC language is RE.

Which of the above statements is/are true?

Have any Doubt ?

A

Both S_1 and S_2

Correct Option

Solution :

(a)

S_1 : If a language is not Recursive, then its complement may be RE or not RE. This is equivaler saying it will be Non REC.

S_2 : REC languages are closed under complementation. Thus, complement will also be REC, we know that every REC is also RE. Therefore S_2 is also true.

Hence answer is (a).

C

Only S_2

D

None of these

QUESTION ANALYTICS

Q. 5

Identify the equivalent non-left recursive CFG for the following grammar G:

$S \to Aa \mid b$
$A \to Ac \mid Aad \mid bd \mid \epsilon$

Have any Doubt ?

A

$S \to Aa \mid b$
$S \to bdA'$
$S \to CA' \mid adA' \mid \epsilon$

B

$S \to Aa \mid b$
$A \to bdA' \mid A'$
$A' \to CA' \mid adA'$

C

$S \to Aa \mid b$
$A \to bdA' \mid A'$
$A' \to cA' \mid adA' \mid \epsilon$

Correct Option

Solution :
(c)

If $A \to A\alpha \mid \beta$, formula to remove left recursion is

$A \to \beta A'$
$A' \to \alpha A' \mid \epsilon$

Now given grammar is

$S \to Aa \mid b$
$A \to Ac \mid Aad \mid bd \mid \epsilon$

Equivalent non-left recursive grammar is

$S \to Aa \mid b$
$A \to bdA' \mid A'$
$A' \to cA' \mid adA' \mid \epsilon$

D

None of these

QUESTION ANALYTICS

Q. 6

Identify the SDT which follow L-attributed definition but not S-attributed definition.

Have any Doubt ?

A

$S \to xy$ {S.a = 20}

C

$S \rightarrow x\ \{S.a = 10 \times 20\} y$

Correct Option

Solution :
(c)
Option (c) is L-attributed grammar but not S-attributed grammar because translation is in between the production.
Option (a) and (b) are L-attributed and also S-attributed.

D

All of these

QUESTION ANALYTICS

Q. 7

Consider the following statements:
S_1 : If the complement of a language L is regular, then L satisfies pumping lemma for regular languages.
S_2 : If the complement of a language L is not regular, L may satisfy pumping lemma for regular languages.
Which of the above statements is/are true?

Have any Doubt ?

A

Both S_1 and S_2

Correct Option

Solution :
(a)
Pumping Lemma for regular languages states that every regular language satisfies pumping len
S_1 : If complement of a language L is regular, then L is also regular. Hence L must satisfy pum
lemma. Hence S_1 is true.
S_2 : We know that L is regular iff L′ is regular. So, if L′ is not regular, L cannot be reg
However that doesn't prevent L from satisfying pumping lemma, as there are some
regular languages which might satisfy pumping lemma.
Hence S_2 is also true.

B

Only S_1

C

Only S_2

D

None of these

QUESTION ANALYTICS

Q. 8

Which of the following sets could result SR conflict in LALR(1) parser?

Have any Doubt ?

A

$A \rightarrow a.b, \{b\}$
$B \rightarrow a., \{a\}$

B

$A \rightarrow b.a, \{b\}$
$B \rightarrow b., \{a\}$

Correct Option

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$A \rightarrow b.a, \{b\}$
$B \rightarrow b., \{a\}$
a belongs to set of look-a-heads of B.
So, SR conflict occurs in option (b).

C
$A \rightarrow a.a, \{a\}$
$B \rightarrow a., \{b\}$

D
$A \rightarrow b.b, \{a\}$
$B \rightarrow b., \{a\}$

QUESTION ANALYTICS

Q. 9

The number of palindromes of length exactly 10, possible over Σ = {a, b, c} are _______.

Have any Doubt ?

243

Correct Option

Solution :
243

The number of palindromes (length = 10) over $\{a, b, c\}$

$$= 3^{10/2} = 3^5$$
$$= 243$$

QUESTION ANALYTICS

Q. 10

Consider the following context free grammar:

$A \rightarrow A + A$
$A \rightarrow (A * A)$
$A \rightarrow id$

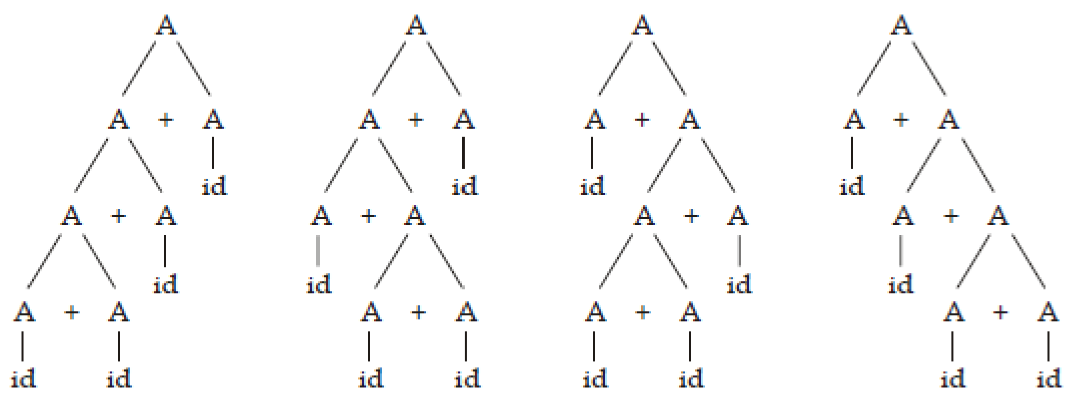
Where set of terminals are {id, (, +,), *} and the set of non-terminals are {A}. The number of parse tree are possible to derive the string “id + id + id + id”
is _______.

Have any Doubt ?

4

Correct Option

Solution :
4



Total 4 parse trees are possible for the sequence id + id + id + id.

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Q. 11

Consider the following grammar G shown below:

$S \to abS \mid ScS \mid d \mid c$

The number of terminals in follow set of non-terminal S is _______.

Have any Doubt ?

2

Correct Option

Solution :
2

Follow (S) = {$, c}

QUESTION ANALYTICS

Q. 12

The number of distinct subwords of the word 'DEPENDABLE' IS _______.

Have any Doubt ?

52

Correct Option

Solution :
52

Subwords of 1 letter $\to$ (D, E, P, N, B, L, A) = 7
Subwords of 2 letters $\to$ 9
Subwords of 3 letters $\to$ 8
Subwords of 4 letters $\to$ 7
$\vdots$
Subwords of 10 letters $\to$ 1

$$= 7 + (9 + 8 + 7 + ... + 3 + 2 + 1)$$

$$= 7 + \frac{9(9+1)}{2} = 52$$

QUESTION ANALYTICS

Q. 13

The length of the shortest string not in the language over Σ = {a, b, c} of the following regular expression(r) is _______.
r = [(a + ba)* bb(a + b)*]*

Have any Doubt ?

1

Correct Option

Solution :
1
It's quite clear to see that since Σ = {a, b, c}, the string c is not in the language.
Hence 1 is the answer.

QUESTION ANALYTICS

Q. 14

Let G be the following grammar:

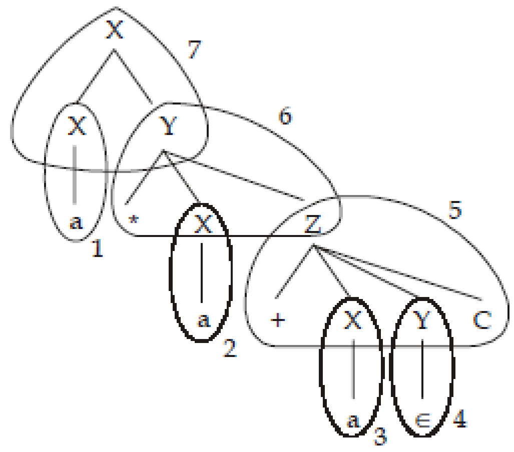
The total number of reduction using LR(1) parser for the string “a * a + ac” is _______.

Have any Doubt ?

7

Correct Option

Solution :
7



Number of reduction = 7

QUESTION ANALYTICS

Q. 15

Consider the following statements:
(i) Three address code is linearized representation of syntax tree.
(ii) The syntax tree does not depicts the hierarchical structure of source program.
The number of the correct statements are _______.

Have any Doubt ?

1

Correct Option

Solution :
1

- Three address code is linearized representation of syntax tree. Hence it is correct.
- The syntax tree depicts the natural hierarchical representation of source program. Hen is wrong.

So only 1 statement is correct.

QUESTION ANALYTICS

Q. 16

Let r and s be two regular expressions on the alphabet {0, 1}.

$r = 10(0 + 1)^*$

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

Let X be another language such that $L(X) = [L(r)]^R \cup L(s)]$. Then the number of states in the minimal DFA which accepts X is _______.

Have any Doubt ?

2

Correct Option

Solution :
2

The reversal of r denotes all the strings ending with 01. And s produces all the strings en with 1. The catch here is that, union will be $(0 + 1)^*1$ as s will generate a superset of the rev of $L(r)$ and will get absorbed while taking union.

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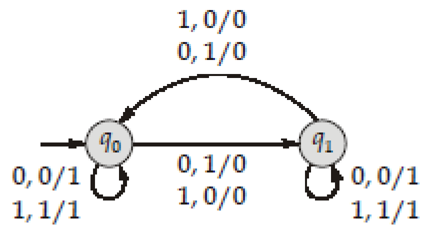
QUESTION ANALYTICS

Q. 17

Consider the following Mealy Machine:



The boolean function computed by the above Mealy Machine M(α, β) is given by

Have any Doubt ?

A

$\alpha + \overline{\beta}$

B

$\alpha \oplus \beta$

C

$\overline{\alpha \oplus \beta}$

Correct Option

Solution :
(c)

The given Mealy Machine computes XNOR.

And we know that $A \odot B = \overline{A \oplus B}$.

Hence answer is (c).

D

$\overline{\alpha}\beta$

QUESTION ANALYTICS

Q. 18

Consider the following grammar:

$E \to (A) \mid c$

$A \to A, E \mid E$

Consider the following LR(0) items corresponding to the above grammar:

1. $E \to A., E$
2. $E \to c.$
3. $E \to (A.)$

Which of the above two will appear in the same set in canonical set of items for the above grammar?

Have any Doubt ?

A

1 and 2 only

B

2 and 3 only

C

1 and 3 only

Correct Option

Solution :
(c)
$A \to A., E$ and $E \to (A.)$ will appear in the same set.

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QUESTION ANALYTICS

Q. 19

Consider the following augmented grammar G:

$$G: E' \rightarrow E$$
$$E \rightarrow abE \mid EcE \mid d \mid e$$

Which of the following is correct about construction of LR(1) parser of grammar G?

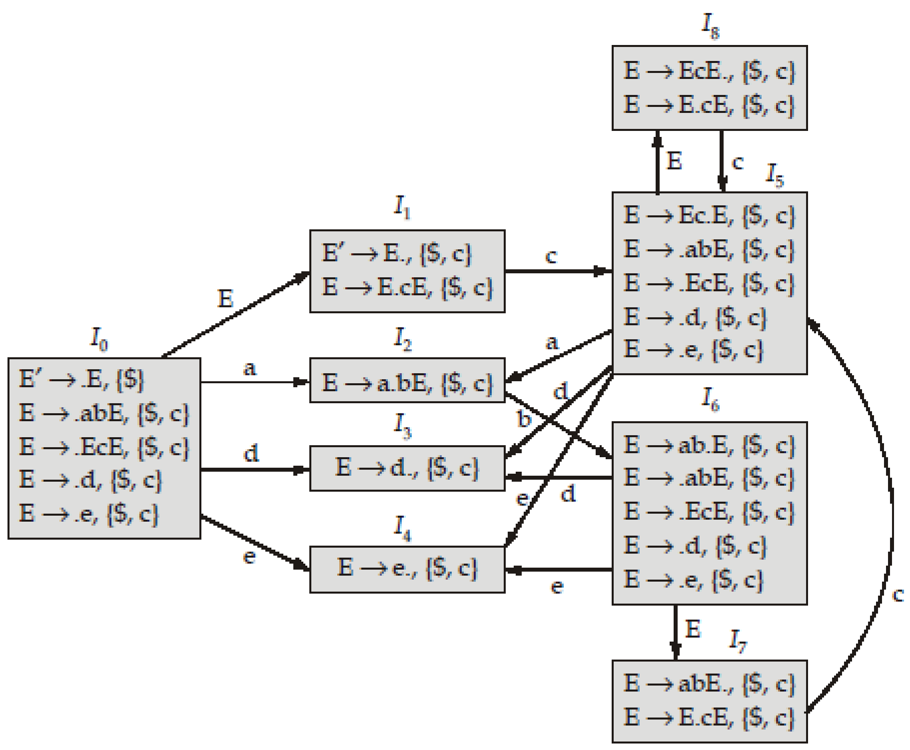
Have any Doubt ?

A

2 states having SR conflicts

Correct Option

Solution :
(a)



In above LR(1), states
I_7 and I_8 having SR conflicts.
So option (a) is correct.

B

2 states having RR conflicts

C

3 states having SR conflicts

D

None of these

QUESTION ANALYTICS

Q. 20

Consider the following grammar G_1, G_2 and G_3:

$$G_1: W \rightarrow XY$$
$$Y \rightarrow aYb \mid \epsilon$$
$$X \rightarrow aX \mid a$$

$$G_2: W \rightarrow XY$$
$$X \rightarrow aXb \mid \epsilon$$
$$Y \rightarrow bY \mid b$$

$$G_3: W \rightarrow XY$$

A
G_1 and G_2 only

B
G_2 and G_3 only

C
Only G_1

D
None of these

Correct Option

Solution :
(d)
G_1 is actually $\{a^m b^n \mid m > n\}$; however aaabbb $\notin L(G_1)$, as G_1 can't generate equal a's and b's.
Hence G_1 doesn't generate aaabbb.
And $L(G_2) = \{a^m b^n \mid m < n\}$; Similar reasoning holds for G_2 and thus aaabbb $\notin L(G_2)$.
But $L(G_3) = \{a^m b^n \mid m \leq n\}$
Hence G_3 is correct, as it can generate equal a's and b's.

QUESTION ANALYTICS

Q. 21

Consider the following statements with respect to storage allocation:
(i) Stack allocation is used for data that may live even after a procedure call returns.
(ii) Heap allocation is used for symbol table.
Which of the above is true?

Have any Doubt ?

A
Only (i)

B
Only (ii)

Correct Option

Solution :
(b)
• Heap allocation is used for data that may live even after procedure call returns not stack allocation.
• Heap allocation is used for dynamic data structure. Symbol table are dynamic data structure.

C
Both are true

D
None of the above

QUESTION ANALYTICS

Q. 22

Let G be a grammar with the productions as below:
S → aSb | bSa | SS | SbS | ∈
Which of the following strings is not generated by G?

Have any Doubt ?

A
abababababab

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C
bbabbabbabba

D
aaababab

Correct Option

Solution :
(d)
The grammar generates all strings w such that number of b's in $w \geq$ number of a's in w. In a number of b's $\geq$ number of a's.
But in (d) number of a's = 5 and number of b's = 3 and therefore can't be generated.

QUESTION ANALYTICS

Q. 23

Consider the following grammars G_1 and G_2 over the alphabet $\{(,), ₹\}$.

G_1: $S \rightarrow (S) \mid S_1$
$S_1 \rightarrow ₹S_1 \mid \in$
G_2: $S \rightarrow)\, S\, (\mid S_1$
$S_1 \rightarrow \in \mid ₹S_1$

Which of the following is incorrect about $L(G_1) \cap L(G_2)$?

Have any Doubt ?

A
It satisfies the Kleene's theorem

B
It satisfies pumping lemma for context free language

C
It is infinite

D
It is finite

Correct Option

Solution :
(d)
$$L(G_1) \cap L(G_2) = (₹)^*$$
It is regular $\Rightarrow$ (a) is correct
Every regular language is context free $\Rightarrow$ (b) is correct.
It is infinite $\Rightarrow$ (c) is also correct.
But (d) is wrong clearly as (c) holds true.

QUESTION ANALYTICS

Q. 24

Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I
A. Target code generation
B. Lexical analyzer
C. Type checking
D. Syntax analyzer

List-II
1. Check the structure of the program.
2. Analysis of entire program by reading each character.

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	A	B	C	D
(a)	4	1	2	3
(b)	4	1	3	2
(c)	3	2	1	4
(d)	3	2	4	1

Have any Doubt ?

A
a

B
b

C
c

D
d

Correct Option

Solution :
(d)
• Lexical analyzer: Analysis of entire program by reading each character.
• Target code generation: Machine dependent language.
• Syntax analyzer: Analyzes syntax on structure of the program.
• Type checking: It determined violation of consistency requirements.

QUESTION ANALYTICS

Q. 25

The number of language that are context free is ________.

$L_1 : \{a^m\, b^n\, c^p\, d^q \mid m = n,\ p = q \text{ and } m, n, p, q \geq 0\}$

$L_1 : \{a^m\, b^n\, c^p\, d^q \mid m = q,\ n = p \text{ and } m, n, p, q \geq 0\}$

$L_3 : \{a^m\, b^n\, c^p\, d^q \mid m + n + p = q\}$

$L_4 : \{a^{2n}\, b^n\, c^n \mid n \geq 0\}$

Have any Doubt ?

3

Correct Option

Solution :
3

For L_1: Push all the a's into the stack; for every b encountered pop a and then if stack is e push all c's and for every d seen, pop c. If stack is empty at the end, accept it.

For L_2: We can easily make a CFG for it. Hence it is also CFL.

For L_3: Push a, b, c's and then match them against d's. Hence CFL.

For L_4: L_4 is actually $= \{a^i\, b^j\, c^k \mid i = 2j \text{ and } j = k\}$. PDA cannot do double comparison with 'AN cases like L_4, as it reflects the inability of one stack to remember once a's are pushed and b' popped, we can't tell if c's were equal to b's or not. Even if we attempt to design a PDA, it accept this language:

$$L(M) = \{a^i\, b^j\, c^k \mid 2i = j + k\}$$

Clearly L(M) is a superset of L_4 as some non members will also get accepted. Hence L_4 is a Hence answer is 3.

QUESTION ANALYTICS

Q. 26

Consider the following syntax directed translation shown below:

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$Z \rightarrow \text{id } \{Z.\text{val} = 1\}$

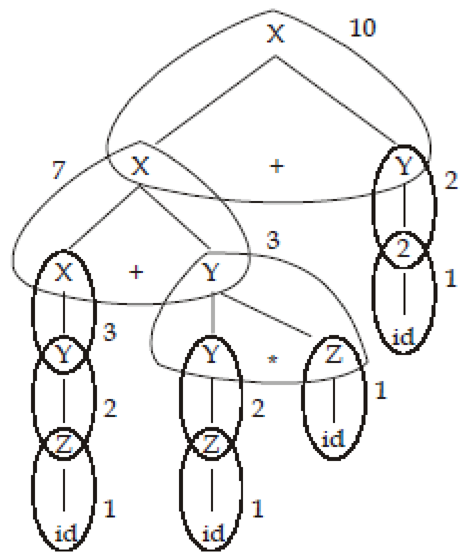
For an input sequence id + id * id + id, the translation will give output _______.

Have any Doubt ?

10

Correct Option

Solution :
10



The above SDT gives 10 as output.

QUESTION ANALYTICS

Q. 27

Consider the following assertions regarding grammars:
1. Every left recursive grammar is ambiguous.
2. For every CFG G, there's an equivalent grammar G' without unit productions, such that L(G') = L(G).
3. For every CFG G, there's an equivalent CFG G' which has no useless productions, such that L(G') = L(G).
4. For every CFG G, there's an equivalent CFG G' without null productions such that L(G') = L(G).
The number of correct statements are _______.

Have any Doubt ?

2

Correct Option

Solution :
2

Statements 2 and 3 are correct. 1 is incorrect because $S \rightarrow Sa \mid \epsilon$ is a left recursive grammar v
is unambiguous.
Statement 4 is false because by removing null productions, the null string (if present in L(G
longer belongs to L(G). The statement 4 therefore holds only for ϵ free languages i.e. langu
which don't contain null string.

QUESTION ANALYTICS

Q. 28

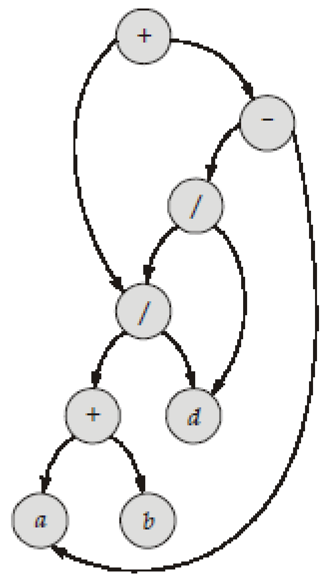
Consider the basic block given below:

$a = a + b$
$c = a / d$
$d = c / d$
$a = d - a$
$a = a + c$

Assume X represents the minimum number of nodes and Y represents the minimum number of edges to represent the above code in the DAG. Then the value of (X + Y) is _______.

Have any Doubt ?

Solution :
18



$$\left.\begin{aligned} a &= a+b \\ c &= a/d \end{aligned}\right\} c = (a+b)/d$$

$$\left.\begin{aligned} d &= c/d \\ a &= d-a \end{aligned}\right\} a = (c/d)-a \Rightarrow a = ((a+b)/d)/d - a$$

Final expression:

$((c/d) - a) + (a+b)/d$

$((a+b/d)/d - a + (a+b)/d$

$X \Rightarrow$ Number of nodes $= 8$

$Y \Rightarrow$ Number of edges $= 10$

So $\quad X + Y = 18$

QUESTION ANALYTICS

Q. 29

Consider a string w of the from $(01)^n$, where $n \geq 0$.
For example, if $n = 3$, then $w = 010101$. If prefix(w) denotes the set of all prefixes of w and suffix(w) denotes the set of all suffixes of w, then the cardinality of prefix(w) $\cap$ suffix(w) for $n = 256$ will be _______.

Have any Doubt ?

257

Correct Option

Solution :
257

$$\begin{aligned}
\text{Let} \qquad n &= 3 \\
\therefore \qquad w &= 010101 \\
\text{prefix}(w) &= \{\epsilon, 0, 01, 010, 0101, 01010, 010101\} \\
\text{suffix}(w) &= \{\epsilon, 1, 01, 101, 0101, 10101, 010101\} \\
\text{prefix}(w) \cap \text{suffix}(w) &= \{\epsilon, 01, 0101, 010101\} \\
\Rightarrow \quad |\text{prefix}(w) \cap \text{suffix}(w)| &= 4
\end{aligned}$$

Take $n = 2$ for confirmation

$$\begin{aligned}
w &= 0101 \\
\text{prefix}(w) &= \{\epsilon, 0, 01, 010, 0101\} \\
\text{suffix}(w) &= \{\epsilon, 1, 01, 101, 0101\} \\
\text{prefix}(w) \cap \text{suffix}(w) &= \{\epsilon, 01, 0101\} \\
\Rightarrow \quad \text{Cardinality} &= 3
\end{aligned}$$

Generalisation of formula:

$$\begin{aligned}
\text{For} \qquad n &= 2, \text{cardinality} = 2 + 1 = 3 \\
n &= 3, \text{cardinality} = 3 + 1 = 4 \\
\text{Hence for} \qquad n &= k, \ |\text{prefix}(w) \cap \text{suffix}(w)| = k + 1 \\
\text{Therefore put} \qquad k &= 256 \Rightarrow 257
\end{aligned}$$

QUESTION ANALYTICS

Consider the below grammar:

$S \rightarrow (L) \mid a$

$L \rightarrow L, S \mid S$

The maximum size of stack during LL(1) parsing for the input string (a, a) is _______.

Have any Doubt ?

4

Correct Option

Solution :
4

First convert the left recursive grammar into non-left recursive

$S \rightarrow (L) \mid a$

$L \rightarrow SL'$

$L' \rightarrow , SL' \mid \epsilon$

First(S) = {(, a} Follow(S) = {\$, ,)}

First(L) = {(, a} Follow(L) = {)}

First(L′) = {, Follow(L′)} Follow(L′) = {)}

So, parsing table of LL(1) will be as follows:

	(	)	a	,	\$
S	$S \rightarrow (L)$		$S \rightarrow a$		
L	$S \rightarrow SL'$		$L \rightarrow SL'$		
L′		$L' \rightarrow \epsilon$		$L' \rightarrow SL'$	

Now for string (a, a)

Stack	Input	Output
\$ S	(a, a) \$	$S \rightarrow (L)$
\$) L (	(a, a) \$	
\$) L	a, a) \$	$S \rightarrow L'$
\$) L′ S	a, a) \$	$S \rightarrow a$
\$) L′ a	a, a) \$	
\$) L′	, a) \$	
\$) L′ S,	, a) \$	$L' \rightarrow .SL'$
\$) L′ S	a) \$	
\$) L′ a	a) \$	$S \rightarrow a$
\$) L′	) \$	
\$)	) \$	$L' \rightarrow \epsilon$
\$	\$	

Maximum size of stack is 4.

QUESTION ANALYTICS

Q. 31

A grammar has no epsilon and unit productions. The maximum number of reduce moves that can be taken during bottom up evaluation of 10 token string by bottom up parsers is _______.

Have any Doubt ?

19

Correct Option

Solution :
19

Maximum number of reduce moves for n token = $2n - 1$

$$\text{So, for 25 tokens} = 2 \times 10 - 1 = 19$$

QUESTION ANALYTICS

Ashima Garg
(Enroll User)

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Ashima Garg
Course: GATE
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Let P denotes the set of all Turing machines which accept their own encoding. Let Q denote the set of all Turing machines which reject their own encoding.
Let X = P $\cup$ Q. Consider the following statements:
1. Both P and Q are decidable
2. Only P is decidable
3. Only Q is decidable
4. Only X is decidable
How many statements are correct _______.

Have any Doubt ?

1

Correct Option

Solution :
1

It is clear that Q is actually P′. And We know that union of any language with its comple contains every string over the input alphabet, which implies X is regular hence recursive, and decidable. But both P and Q are individually undecidable, hence only statement 4 is co Hence number of correct statements = 1.

QUESTION ANALYTICS

Q. 33

Consider the following grammar:

$X \rightarrow Y \mid aXb$

$Y \rightarrow aY \mid f$

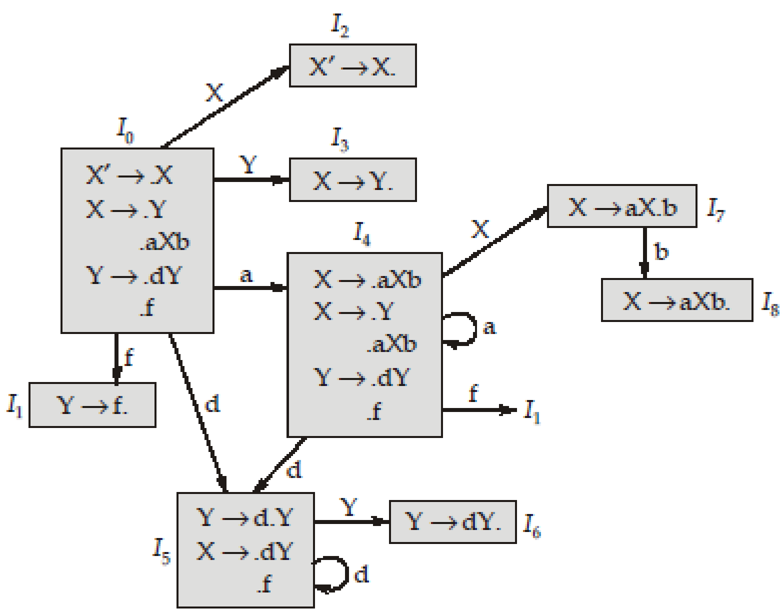
The total number of inadequate states in SLR(1) parsing table of the above grammar are _______.

Have any Doubt ?

0

Correct Option

Solution :
0



Inadequate state = Number of SR conflict or RR conflict states

Number of inadequate state = 0

QUESTION ANALYTICS