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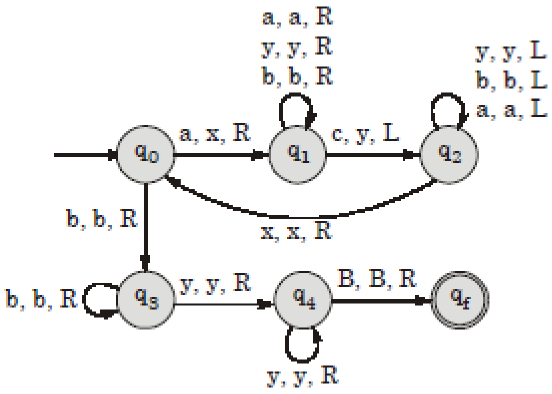
TOPICWISE : THEORY OF COMPUTATION-2 (GATE - 2019) - REPORTS

OVERALL ANALYSIS | COMPARISON REPORT | SOLUTION REPORT

ALL(17) | CORRECT(11) | INCORRECT(4) | SKIPPED(2)

Q. 1

Consider the following TM:



Note: (a, b, c) represents: by reading input 'a', it replaces 'a' by 'b' and moves to 'c' direction.
Which of the following language accepted by above TM?

Solution Video | Have any Doubt ?

A
$\{a^m b^n c^k \mid m, n, k \geq 0, m = k\}$

B
$\{a^m b^n c^k \mid m, n, k \geq 0, m = n\}$

C
$\{a^m b^n c^k \mid m, n, k > 0, m = k\}$

Your answer is **Correct**

Solution :
(c)

$$L = \{a^m b^n c^k \mid m, n, k > 0 \text{ and } m = k\}$$

Here, a's are replaced by x and c's are replaced by y in every scan from $q_0 \to q_1 \to q_2 \to q_0$
To reach final state, atleast one b should appear and atleast one y (y represents c hence a also appear) should appear.

$\therefore$ $L = a^i b^j c^i \mid i, j > 0\}$ is accepted by TM

So option (c) is correct.

D
$\{a^m b^n c^k \mid m, n, k > 0, m = n\}$

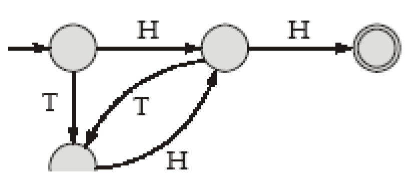
QUESTION ANALYTICS

Q. 2

Consider a Game played be between two players (Player-1, Player-2) repeatedly flip a coin:
On output as a head, **Player-1** get a point
On output as a tail, **Player-2** get a point
A player wins if his score reaches 2 points before the other player by reaching final state. Which of the following depicts NFA for above problem?

FAQ | Solution Video | Have any Doubt ?

A



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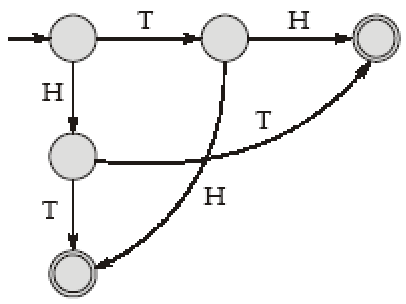
Your answer is Correct

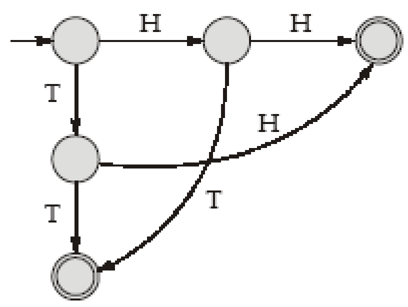
Solution :
(a)

In NFA given by option (a) possibilities at final state are:
H(T H)* H
T(H T)* T
Which shows atleast one player is winning i.e. getting two points 1st by reaching at final sta

B



C



D

None of these

QUESTION ANALYTICS

Q. 3

Which of the following represents the grammar for language L = {w | n_a(w) and n_b(w) are both even}?}

Solution Video | Have any Doubt ?

A

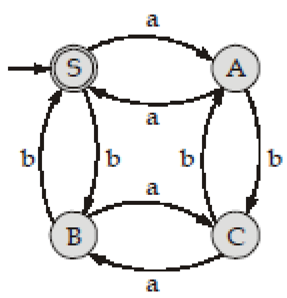
$S \to aA \mid bB$
$A \to bC \mid aS$
$B \to aC \mid bS$
$C \to aB \mid bA$

B

$S \to aA \mid bB \mid \epsilon$
$A \to bC \mid aS$
$B \to aC \mid bS$
$C \to aB \mid bA$

Correct Option

Solution :
(b)



Option (b) can be obtained from the DFA given above.
Therefore (b) is correct.

$A \to bS \mid aS$
$B \to aS \mid bS$

D

$S \to aA \mid bB \mid \epsilon$
$A \to bS \mid aC$
$B \to bC \mid aS$
$C \to aB \mid bA$

Your answer is **Wrong**

QUESTION ANALYTICS

Q. 4

Consider <M> be the encoding of a Turing Machine as a string over alphabet Σ = {0, 1}. Consider L = {<M>|M is TM that halt on all input and L(M) = L' for some undecidable language L'}. Then L is

FAQ | Solution Video | Have any Doubt ?

A
Decidable and recursive

Your answer is **Correct**

Solution :
(a)
Since M is a TM that halts on all input, so L(M) is decidable. So, L(M) ≠ L′. Since decid
language cannot be equal to some undecidable language.
So, $L = \phi$
Hence decidable and recursive.

B
Decidable and non-recursive

C
Undecidable and recursively enumerable

D
Undecidable and non-recursively enumerable

QUESTION ANALYTICS

Q. 5

Which of the decision problems are decidable?

FAQ | Solution Video | See your Answers

A
Given a RE grammar G, is $L(G) = \Sigma^*$?

Your answer is **Wrong**

B
Given two deterministic CFG G_1 and G_2, is $L(G_1) \cap L(G_2) = \phi$?

C
Given two deterministic CFG G_1 and G_2, is $L(G_1) = L(G_2)$?

Correct Option

Solution :
(c)

- For RE grammar, $L(G) = \Sigma^*$ i.e. RE grammar accept everything is undecidable.
- For two DCFG, $L(G_1) \cap L(G_2) = \phi$ is undecidable since $L(G_1) \cap L(G_2) = \phi \equiv \overline{L(G_1)} \cup \overline{L(G_2)} = \phi$ i.e.

D

Given two CFG G_1 and G_2, is $L(G_1) = L(G_2)$?

QUESTION ANALYTICS

Q. 6

Consider the following language:

$L_1 = \{0^l 1^m 0^{l+m} \mid l, m \geq 0\}$ $\quad$ $L_2 = \{0^l 1^{2l} 0^n \mid l \geq 0, n \geq 0\}$

$L_3 = \{0^l 1^{2l} 0^{l+n} \mid l \geq 0, n \geq 0\}$ $\quad$ $L_4 = \{0^m 1^n 2^m 3^n \mid m, n > 0\}$

The number of languages are DCFL ________.

Solution Video | Have any Doubt ?

2

Your answer is Correct2

Solution :
2

L_1 : is DCFL, push all 0's and 1's in the stack the for every 0 of the string, start popping fron stack.

L_2 : is DCFL, for every 0 in the string push two 0's in the stack, for every '1', pop a '0' fron stack, then skip operation will be applied on all 0's.

L_3 : $0^l 1^{2l} 0^l 0^n$, this is not even a CFG. Due to three level dependency, it can't be solved using si stack.

L_4 : Here we need to compare each 2 with 0 and each 3 with 1. However, in both the cases to stack contains 1's and 2's respectively. So, can't be solved using single stack.

QUESTION ANALYTICS

Q. 7

Let L = $\{(a^P)^* \mid$ P is a prime number$\}$ and $\Sigma=\{a\}$. The minimum number of states in NFA that accepts the language L are ________.

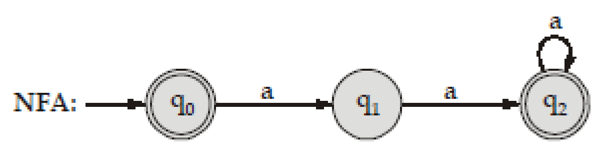
FAQ | Solution Video | Have any Doubt ?

3

Correct Option

Solution :
3

$$\begin{aligned} L &= \{(a^P)^* \mid P \text{ is a prime}\} \\ &= (a^2)^* \cup (a^3)^* \cup (a^5)^* \cup \ldots = \{\varepsilon, a^2, a^3, a^4, a^5, a^6, \ldots\} \\ &= \text{All strings of a's except the string a} \\ &= \{a^n \mid n = 0 \text{ or } n \geq 2\} \end{aligned}$$



Number of states = 3.

Your Answer is 1

QUESTION ANALYTICS

Q. 8

Consider the context free grammars over the alphabet {a, b} given below. S is non-terminal:

4

Your answer is **Correct**4

Solution :
4

$$L(G_1) = \text{Set of even palindromes}$$
$$L(G_2) = (aa + bb)^*$$

So, string "aabb" or "bbaa" belongs to $L(G_2)$ but not to $L(G_1)$.
Hence 4 is answer.

QUESTION ANALYTICS

Q. 9

Consider the following two statements with respect to countability?
Statement 1: If A ∪ B is uncountable, then both set A and set B must be uncountable.
Statement 2: The Cartesian product of two countable sets A and B is countable.
The number of the above two statements correct are ______.

Solution Video | Have any Doubt ?

1

Your answer is **Correct**1

Solution :
1
Statement-1: This is incorrect i.e. atleast one set can be uncountable but need not be both.
Statement-2: Cartesian product of two countable sets A and B is countable.

QUESTION ANALYTICS

Q. 10

Consider the following statements:
S_1 : Pumping lemma can be used to prove given language is regular.
S_2 : Given a grammar, checking if the grammar is not regular is decidable problem.
S_3 : If L is a regular and M is not a regular language then L.M. is necessarily non-regular.
S_4 : The number of derivations step for any strings W of length n is grammar is CNF and GNF form is $(2n - 1)$ and (n) respectively.
Which of the following statement is correct ?

Solution Video | Have any Doubt ?

A
Only S_1, S_3 is correct

B
Only S_2, S_4 is correct

Your answer is **Correct**

Solution :
(b)

S_1 : Pumping lemma can prove that language is not regular but can't prove that the langua
regular. Hence this is false.
S_2 : We can check regular grammar by following productions $V \rightarrow T^*\ V + T^*$ or $V \rightarrow V\ T^* +$
S_3 : Consider 'L' to be ϕ and 'M' to $\{a^n b^n \mid n \leq 0\}$
L.M. = ϕ, which is regular
S_4 : In case of CNF, $(n - 1)$ derivations are required to generate a string with (n) Non-Termi
since only one Non-Terminals is added during each derivation.
Further, (n) derivations are required to convert those Non-Terminals to terminals.
So, in total, to generate a string of n terminals:

$$(n-1) \quad + \quad (n) \quad = \quad (2n-1)$$

However, in case of GNF: In a single derivation, we get a terminal in addition to our Non Terminals. $S \to T(NT)^*$
Therefore, no need for $(n - 1)$ derivations to increase length.
Hence, only (n) derivations are required.

C
Only S_3 is correct

D
Only S_2, S_3 is correct

QUESTION ANALYTICS

Q. 11

Consider L_1, L_2 be any two context sensitive languages and R be any regular language. Then which of the following is/are correct?

I. $L_1 \cup R$ is regular.
II. $\overline{L_2}$ is context sensitive language.
III. $L_1 \cap L_2$ is context sensitive.
IV. $L_1 - L_2$ is non-CSL.

Solution Video | Have any Doubt ?

A
I, II and IV only

B
II and III only

Correct Option

Solution :
(b)

- $L_1 \cup R$ = CSL $\cup$ Reg = CSL but need not regular.
- $\overline{L_2}$ = $\overline{\text{CSL}}$ = CSL, since CSL closed under complement.
- $L_1 \cap L_2$ = CSL $\cap$ CSL = CSL, since CSL closed under intersection.
- $L_1 - L_2$ = CSL − CSL = CSL $\cap$ $\overline{\text{CSL}}$ = CSL, since CSL are closed under intersection complement.

So, only II and III are true.

C
I and IV only

D
II, III and IV only

QUESTION ANALYTICS

Q. 12

Which of the following are context free?

$L_1 : \{a^n b^m a^k \mid k = mn \text{ and } k, m, n \geq 1\}$
$L_2 : \{a^{m+n} b^{n+m} c^m \mid n, m \geq 1\}$
$L_3 : \{a^n b^n c^m \mid m < n \text{ and } m, n \geq 1\}$

FAQ | Solution Video | Have any Doubt ?

A
L_1 and L_2 only

B
L_2 and L_3 only

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D

None of the language

Correct Option

Solution :

(d)

$L_1 : \{a^n b^m a^k \mid k = mn\}$ is not CFL, since we can not implement it with single stack.

$L_2 : \{a^{m+n} b^{n+m} c^m \mid n, m \geq 1\}$ is non-CFL since here more than 1 comparison present i.e., $\{a^m a^n b^n b^m c^m\}$. Hence cannot be implement by single stack.

$L_3 : \{a^n b^n c^m \mid m < n$ and $m, n \geq 1\}$ is non-CFL since more than 1 comparison are pre simultaneously. i.e. after comparison of $n = n$, we left with only c^m and we cannot com $m < n$ or not.

So, none of the language is CFL.

QUESTION ANALYTICS

Q. 13

Identify the language generated by the following grammar where S is start variable?

$S \rightarrow S_1 \mid S_2$

$S_1 \rightarrow S_1 c \mid A$

$A \rightarrow aAb \mid \in$

$S_2 \rightarrow aS_2 \mid B$

$B \rightarrow bBc \mid \in$

Solution Video | Have any Doubt ?

A

{a^n b^n c^mâ□□n, m ≥ 0}

B

{a^n b^m c^kâ□□n, m, k ≥ 0}

C

{a^n b^m c^mâ□□n, m ≥ 0}

D

{a^n b^n c^mâ□□n, m ≥ 0} ∪ {a^n b^m c^mâ□□n, m ≥ 0}

Your answer is **Correct**

Solution :

(d)

$L_1 : S_1 \rightarrow S_1 c \mid A \Leftarrow \{a^n b^n c^m \mid n, m \geq 0\}$

$A \rightarrow aAb \mid \in\ = \{a^n b^n \mid n \geq 0\}$

$L_2 : S_2 \rightarrow aS_2 \mid B \Leftarrow \{a^n b^m c^m \mid n, m \geq 0\}$

$B \rightarrow bBc \mid \in\ \Rightarrow \{b^m c^m \mid m \geq 0\}$

So, $L = L_1 \cup L_2 = \{a^n b^n c^m \mid n, m \geq 0\} \cup \{a^n b^m c^m \mid n, m \geq 0\}$.

QUESTION ANALYTICS

Q. 14

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

I. $L_1 \cdot L_2$ is non CFL

II. $L_1 \cdot L_2 = \{a^n b^{2n} c^n \mid n \geq 0\}$

Which one of the following is correct?

Solution Video | Have any Doubt ?

A

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Only II

C
Both I and II

D
Neither I nor II

Your answer is **Correct**

Solution :
(d)

$$L_1 = \{a^n b^n \mid n \geq 0\} \text{ is DCFL and CFL also.}$$
$$L_2 = \{b^n c^n \mid n \geq 0\} \text{ is DCFL and CFL also.}$$

We know that CFL · CFL = CFL

So, $L_1 \cdot L_2 = \{a^n b^n b^m c^m \mid n, m \geq 0\}$ which is CFL and we can see that $L_1 \cdot L_2$ is clearly not equ
$\{a^n b^{2n} c^n \mid n \geq 0\}$.

So II is not true.

So answer is option (d).

QUESTION ANALYTICS

Q. 15

The number of strings present of length 10 in language $L = \{a^{2n+1} b^{2m+1} \mid n \geq 0, m \geq 0\}$ are ______.

FAQ | Solution Video | Have any Doubt ?

5

Your answer is **Correct**5

Solution :
5

$$\text{Language } L = \{a^{2n+1} b^{2m+1} \mid n \geq 0, m \geq 0\}$$
$$\text{Regular expression} = (aa)^* a\, (bb)^* b$$

Since we need to find number of strings of length 10,

$$|a^{2n+1} b^{2m+1}| = 2n + 1 + 2m + 1$$
$$= 2(m + n) + 2$$

Now $\quad 2(m + n) + 2 = 10$

$$m + n = 4$$

$\therefore$ Number of solutions of this equation $= 5$

QUESTION ANALYTICS

Q. 16

Consider the following Problems:

P_1: {<M, x, k> | M is a TM and M does not halt on x within k steps}

P_2: {<M> | M is a TM and M accepts atleast two strings of different length}

P_3: {<M> | M is a TM and there exist an input whose length is less than 100, on which M halts}

The number of problems which is RE but not REC is ______.

FAQ | Solution Video | Have any Doubt ?

2

Correct Option

Solution :
2

P_1: T_{Yes} : When machine does not halt on x until k steps.

T_{No}: When machine halt on x within k steps.

So, recursive.

T_{No}: Does not exist, since machine may go into infinite loop.
So, RE but not REC.

Your Answer is 1

QUESTION ANALYTICS

Q. 17

Consider the following CFG:

$S \rightarrow aSa \mid bSb \mid a \mid b \mid \varepsilon$

For the above CFG, the total number of strings generated whose length is less than or equal to 6 is ________.

FAQ | Solution Video | Have any Doubt ?

29

Your answer is **Correct**29

Solution :
29

The grammar generates the set of all palindromes possible over $\{a, b\}$.

Lets first find the number of even palindromes of length atmost 6 (0, 2, 4, 6 length respecti

$$\begin{aligned}
0 \text{ length palindromes} &= 2^{0/2} = 1 \\
2 \text{ length palindromes} &= 2^{2/2} = 2 \\
4 \text{ length palindromes} &= 2^{4/2} = 4 \\
6 \text{ length palindromes} &= 2^{6/2} = 8
\end{aligned}$$

So total number of even palindromes of length atmost 6 = 1 + 2 + 4 + 8 = 15

Similarly number of odd palindromes of length atmost 6 = 2 + 4 + 8 = 14

So total palindromes = 29

QUESTION ANALYTICS