



Kunal Jha
 Course: GATE
 Computer Science Engineering(CS)

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THEORY OF COMPUTATION + COMPILER DESIGN (GATE - 2021) - REPORTS

OVERALL ANALYSIS COMPARISON REPORT **SOLUTION REPORT**

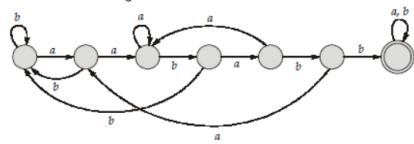
ALL(33) CORRECT(0) INCORRECT(0) SKIPPED(33)

Q. 1

Have any Doubt ?



Consider the following Deterministic Finite Automata:



Which of the following is true?

A It only accepts strings with prefix as "aababb"

Correct Option

B It only accepts strings with substring as "aababb"

Solution :

(b)

To reach the accepting state, any string will have to go through edges having aababb as labels in order. Though it might not be a continuous substring, but it sure will be a substring. There might be some cases where same substring always exists as a prefix or suffix for some DFA, but in this situation we don't have to consider those cases, given this question has single choice answer.

$\rightarrow O \rightarrow a \rightarrow O \rightarrow a \rightarrow O \rightarrow b \rightarrow O \rightarrow a \rightarrow O \rightarrow b \rightarrow O \rightarrow b \rightarrow O$

Hence, correct answer should be (b).

C It only accepts strings with suffix as "aababb"

D None of the above

QUESTION ANALYTICS



Q. 2

Have any Doubt ?



Pushdown automata can recognize language generated by _____.

A Only context free grammar

B Only regular grammar.

C Context free grammar or regular grammar.

Correct Option

Solution :

(c)

Pushdown automata can recognize language generated by Context free grammar or regular grammar.

So, option (c) is correct.

D Only context sensitive grammar.

QUESTION ANALYTICS



Q. 3

Have any Doubt ?



The context free grammar given by

$S \rightarrow XYX$

$X \rightarrow aX \mid bX \mid \lambda$

$Y \rightarrow bbb$

Generates the language which is defined by regular expression:

A $(a+b)^*bbb$

B $abbb(a+b)^*$

C $(a+b)^*(bbb)(a+b)^*$

Correct Option

Solution :

(c)

$S \rightarrow XYX$

$X \rightarrow aX \mid bX \mid \lambda$

i.e. $(a+b)^*$

$Y \rightarrow bbb$

$S \rightarrow (a+b)^*(bbb)(a+b)^*$

So, option (c) is correct.

D (a + b)(bbb)(a + b)*

QUESTION ANALYTICS

Q. 4

Have any Doubt?

If all the production rules have single non-terminal symbol on the left side, the grammar defined is:

A Context free grammar

Correct Option

Solution :

(a)
If all the production rules have single non-terminal symbol on the left side, the grammar defined is context free grammar.

B Context sensitive grammar

C Unrestricted grammar

D Phrase grammar

QUESTION ANALYTICS

Q. 5

FAQ Solution Video

Have any Doubt?

Given the following two languages:

$$L_1 = \{a^n b a^n \mid n > 0\}$$

$$L_2 = \{a^n b a^n b^{n+1} \mid n > 0\}$$

Which of the following is correct?

A L_1 is context free language and L_2 is not context free language.

Correct Option

Solution :

(a)
Language L_1 is context free language as $L_1 = \{a^n b a^n \mid n > 0\}$, we can compare number of a's before b and number of a's after b both are equal using only one stack using push and pop function but we can not compare language L_2 .

$L_2 = \{a^n b a^n b^{n+1} \mid n > 0\}$ using only one stack here we can compare all number of a's before b and number of a's after b both are equal using only one stack using push and pop function but we cannot compare all $bn + 1$ at that time.

Hence, L_1 is context free language and L_2 is not context free language.

B L_1 is not context free language and L_2 is context free language.

C Both L_1 and L_2 are context free languages.

D Both L_1 and L_2 are not context free languages.

QUESTION ANALYTICS

Q. 6

FAQ Solution Video

Have any Doubt?

The pushdown automation $M = (\{q_0, q_1, q_2\}, \{a, b\}, \{0, 1\}, \delta, q_0, 0, [q_0])$ with

$$\delta(q_0, a, 0) = \{q_1, 10\}$$

$$\delta(q_1, a, 1) = \{q_1, 11\}$$

$$\delta(q_1, b, 1) = \{q_2, \lambda\}$$

$$\delta(q_2, b, 1) = \{q_2, \lambda\}$$

$$\delta(q_2, \lambda, 0) = \{q_0, \lambda\}$$

Accepts the language

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

B $L = \{a^n b^n \mid n \geq 0\}$

Correct Option

Solution :

(b)

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

D $L = \{a^n b^n \mid n > 0\}$

Q. 7

[▶ Solution Video](#)[Have any Doubt ?](#)

Consider the languages $L_1 = \emptyset$ and $L_2 = \{1\}$. Which one of the following represents $L_1^* \cup L_1^* \cdot L_2^*$?

A $\{\epsilon\}$ **B** $\{\epsilon, 1\}$ **C** \emptyset **D** 1^*

Correct Option

Solution :
(d)

$$\begin{aligned}L_1^* &= \{\emptyset\}^* = \epsilon \\L_1^* \cdot L_2^* &= \epsilon \cup 1^* = 1^* \\L_1^* \cup L_1^* \cdot L_2^* &= \epsilon \cup 1^* = 1^*\end{aligned}$$

Q. 8

[FAQ](#)[▶ Solution Video](#)[Have any Doubt ?](#)

Given the following two languages:

$$L_1 = \{a^n b^n \mid n \geq 0, n \neq 100\}$$

$$L_2 = \{w \in \{a, b, c\}^* \mid n_a(w) = n_b(w) = n_c(w)\}$$

Which of the following options is correct?

A Both L_1 and L_2 are not context free language.**B** Both L_1 and L_2 are context free language.**C** L_1 is context free language, L_2 is not context free language.

Correct Option

Solution :
(c).

Language $L_1 = \{a^n b^n \mid n \geq 0, n \neq 100\}$ is context free because we push all the a^n into the stack and pop all b^n element for each a^n element since we can compare all a's and b's here using only one stack.

But language $L_2 = \{w \in \{a, b, c\}^* \mid n_a(w) = n_b(w) = n_c(w)\}$ is not context free language because we can not compare all a's, b's and c's simultaneously with the help of only one stack for this we need more than one stack here then this language L_2 becomes context sensitive language.

Option (c) is correct.

D L_1 is not context free language, L_2 is context free language.

Q. 9

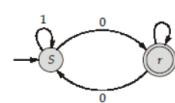
[Have any Doubt ?](#)

How many minimum states are required in a DFA to find whether a given binary string has odd number of 0's or not, there can be any number of 1's.

2

Correct Option

Solution :
2



Q. 10

[Have any Doubt ?](#)

The number of tokens in the following C statement is `printf("i = %d, &i = %x", i, &i);`

10

Correct Option

Solution :

10
In a C source program, the basic element recognized by the compiler is the "token." A token is source-program text that the compiler does not break down into component elements. There are 6 types of C tokens: identifiers, keywords, constants, operators, string literals and other separators. There are total 10 tokens in the above printf statement.

Below are tokens in above program.

```
printf
(
"i = %d, &i = %x"
)
;
```

 QUESTION ANALYTICS

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Q. 11

FAQ Solution Video Have any Doubt ?

How many strings of length less than 4 contains the language described by the regular expression
 $(x + y)^* y(a + ab)^*$?

12

Correct Option

Solution :

12
 $y, xy, yy, ya, xxy, xyy, yyyy, yxy, yab, yaa, yya, xya$
 String of length 1 = 1
 String of length 2 = 3
 String of length 3 = 8

QUESTION ANALYTICS

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Q. 12

Solution Video Have any Doubt ?

Consider the following grammar:
 Non terminals – S, A, B, C
 Terminals - a, b, c
 \in - Epsilon
 $S \rightarrow abABC$
 $A \rightarrow bc \mid a$
 $B \rightarrow a \mid c \mid \in$
 $C \rightarrow b \mid \in$
 How many elements will be there in follow of A?

4

Correct Option

Solution :

4
 $\text{Follow}(A) = \{a, b, c, \$\}$
 $\text{Follow}(A) = \text{First}(B) \cup \text{First}(C) \cup \text{Follow}(S).$

QUESTION ANALYTICS

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Q. 13

FAQ Solution Video Have any Doubt ?

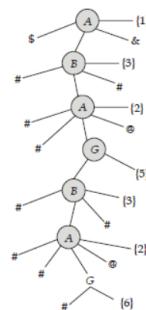
Write the sum of the output of following SDT _____.
 $\text{Alpha} \rightarrow \$\text{Beta} \& \{\text{printf}(1)\}; | \# \# \text{Gamma} @ \{\text{printf}(2)\}$
 $\text{Beta} \rightarrow \# \text{Alpha} \# \{\text{printf}(3)\}$
 $\text{Gamma} \rightarrow \& \text{Gamma} \& \{\text{printf}(4)\}; | \text{Beta} \{\text{printf}(5)\}; | \# \{\text{printf}(6)\}$
 Non-terminals (V) = {Alpha, Beta, Gamma}
 Terminals (T) = { \$, &, #, @ }
 String : \$ # # # # # @ # @ # &

22

Correct Option

Solution :

22



QUESTION ANALYTICS

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Q. 14

Have any Doubt?



Which one of the following statements is TRUE?

A Context-free grammar can be used to specify both lexical and syntax rules.

Correct Option

B Type checking is done before parsing.

C High-level language programs can be translated to different Intermediate Representations.

Correct Option

D Arguments to a function can be passed using the program stack.

Correct Option

YOUR ANSWER - NA

CORRECT ANSWER - a,c,d

STATUS - SKIPPED

Solution :

(a, c, d)

Type checking is done at semantic analysis phase and parsing is done at syntax analysis phase. And we know Syntax analysis phase comes before semantic analysis. So Option (B) is False. All other options seems Correct.

QUESTION ANALYTICS



Q. 15

FAQ

Have any Doubt?



Which of the above statement(s) is/are correct w.r.t compiler construction?

A Lexical Analysis is specified by context-free grammars and implemented by pushdown automata.

B Syntax Analysis is specified by regular expressions and implemented by finite-state machine.

C A function of a linker is to combine several object modules into a single load module.

Correct Option

D A function of a linker is to replace absolute references in an object module by symbolic references to locations in other modules.

YOUR ANSWER - NA

CORRECT ANSWER - c

STATUS - SKIPPED

Solution :

(c)

A linker is computer software that combine two or more file generated by compiler into a single executable file. Option (c) is correct but (d) option doesn't resemble linker. Also both (a) and (b) are wrong.

QUESTION ANALYTICS



Q. 16

Solution Video

Have any Doubt?



CFG (Context Free Grammar) is closed under:

A Union

Correct Option

B Complementation

C Kleene star

Correct Option

D Product

Correct Option

YOUR ANSWER - NA

CORRECT ANSWER - a,c,d

STATUS - SKIPPED

Solution :

(A, C, D)

Context free languages (CFL) are closed under union, concatenation (product) and kleene closure but not closed under intersection and complementation.

QUESTION ANALYTICS



Q. 17

FAQ

Have any Doubt?



Let $L = \{0^n 1^n | n \geq 0\}$ be a context free language.

Which of the following is correct?

A L' is context free and L^k is not context free for any $k \geq 1$.

B L' is not context free and L^k is not context free for any $k \geq 1$.

C Both L' and L^k for any $k \geq 1$ are context free.

Correct Option

D Both L' and L^k for any $k \geq 1$ are not context free.

QUESTION ANALYTICS

Q. 18

Have any Doubt?



Consider the following expression:

$$u * v + a - b * c$$

Which one of the following corresponds to a static single assignment from the above expressions

A $x_1 = a - b$

$$y_1 = p * c$$

$$x_2 = u * v$$

$$y_2 = p + q$$

B $x_1 = a - b$

$$y_1 = x_2 * c$$

$$x_3 = u * v$$

$$y_2 = x_4 + y_3$$

C $x_1 = a - b$

$$y_2 = x_1 * c$$

$$x_2 = u * v$$

$$y_3 = x_2 + y_2$$

Correct Option

Solution :

(c)

According to Static Single Assignment:

1. A variable cannot be used more than once in the LHS.
2. A variable should be initialized atmost once.

So, only option (c) is correct.

D $p = a - b$

$$q = p * c$$

$$p = u * v$$

$$q = p + q$$

QUESTION ANALYTICS

Q. 19

Have any Doubt?



The regular expression with all strings of 0's and 1's with at least two consecutive 0's is?

A $1 + (10)^*$

B $(0 + 1)^* 00 (0 + 1)^*$

Correct Option

Solution :

(b)

The expression $(0 + 1)^* 00 (0 + 1)^*$ is where either it initially takes 0 or 1 or 00 followed by string of combination of 0 and 1.

C $(0 + 1)^* 011$

D $0^* 1^* 2^*$

QUESTION ANALYTICS

Q. 20

FAQ Have any Doubt?



Which of the following is correct with respect to the grammar given below?

$$S \rightarrow CC$$

$$C \rightarrow eC \mid d$$

A LL(1)

Correct Option

Solution :

(a)

B SLR(1) but not LL(1)

C LALR(1) but not SLR(1)

D LALR(1) but not SLR(1)

QUESTION ANALYTICS





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Q. 21

FAQ Solution Video Have any Doubt ?

Which of the following languages is/are regular?

$L_1 : \{wxw^R \mid w, x \in \{a, b\}^*\text{ and }|w|, |x| > 0\}$ w^R is the reverse of string w .

$L_2 : \{a^nb^m \mid m \neq n \text{ and } m, n \geq 0\}$.

$L_3 : \{a^pb^qc^r \mid p, q, r \geq 0\}$

A L_1 and L_3 only

Correct Option

Solution :

(a)

L_3 is simple to guess, it is regular.

Below is DFA for L_3 :



L_1 is interesting. The important thing to note about L_1 is length of x is $4w$ greater than 0.

Thus, wxw^R can become all those strings that starts and ends with same symbol.

B L_2

C L_2 and L_3 only

D L_3 only

QUESTION ANALYTICS

Q. 22

Solution Video Have any Doubt ?

Assume the statements S_1 and S_2 given as:

S_1 : Given a context free grammar, there exists an algorithm for determining whether $L(G)$ is infinite.

S_2 : There exists an algorithm to determine whether two context free grammars generate the same language.

Which of the following is true?

A S_1 is correct and S_2 is not correct.

Correct Option

Solution :

(a)

The proof of S_1 can be seen in various book of theory of computation but S_2 is a problem of category undecidable so a contradiction to this assumption can be easily obtained.

B Both S_1 and S_2 are correct.

C Both S_1 and S_2 are not correct.

D S_1 is not correct and S_2 is correct.

QUESTION ANALYTICS

Q. 23

Solution Video Have any Doubt ?

If P and R are regular and also given that if $PQ = R$, then?

A Q has to be regular.

B Q cannot be regular.

C Q need not be regular.

Correct Option

Solution :

(c)

If we take $P = \phi$ which is regular

Now, $\phi \cdot \text{Any language} = \phi$ which is regular.

Thus Q need not be regular.

D Q has to be a CFL.

Q. 24

Solution Video

Have any Doubt ?



Which of the following is true?

 A All subsets of a regular set are always regular. B All finite subsets of non-regular set are always regular.

Correct Option

Solution :

- (b)
 (a) is false. As $a^n b^n \subset a^* b^*$ but $a^n b^n$ is not regular.
 (b) is true. As any finite language is regular.
 (c) is false. As it may be regular for e.g. $\{a^n b^m \mid n = m\} \cup \{a^n b^m \mid n \neq m\} = a^* b^*$ (regular).
 (d) is false.

 C Union of two non regular set of language is not regular. D Infinite times union of finite set is always regular.

Q. 25

Have any Doubt ?



Number of elements in follow of A in the following grammar?

 $T \rightarrow AB$ $A \rightarrow a \mid b$ $B \rightarrow c \mid d$ 2

Correct Option

Solution :

2
 $\text{Follow}(a) = \{c, d\}$

Q. 26

FAQ Have any Doubt ?



Consider the following grammar:

 $S \rightarrow ABA$ $A \rightarrow Bc \mid dA \mid \epsilon$ $B \rightarrow eA$

How many entries have multiple productions in LL(1) table?

 2

Correct Option

Solution :

2

$\text{First}(S) = \{d, e\}$
 $\text{First}(A) = \{d, e, \epsilon\}$
 $\text{Follow}(A) = \{c, d, e, \$\}$
 $\text{First}(B) = \{e\}$

	c	d	e	\$
S		ABA	ABA	
A	ϵ	dA, ϵ	Bc, ϵ	ϵ
B			eA	

Two entries have multiple productions.

Q. 27

Have any Doubt ?



Consider the following grammar.

 $S \rightarrow A \mid BC$ $A \rightarrow xAz \mid B$ $C \rightarrow yCz \mid \epsilon$ $B \rightarrow xBy \mid \epsilon$

Number of elements in the set of First of S?

 4

Correct Option

Solution :

4

$$\begin{aligned}
 F(S) &= F(A) \cup F(BC) \\
 &= \{x, e\} \cup F(B) \\
 &= \{x, e\} \cup \{x, e\} - \{e\} \cup F(C) \\
 &= \{x, e\} \cup \{y\} \cup \{e\} \\
 &= \{x, y, e\}
 \end{aligned}$$

QUESTION ANALYTICS



Q. 28

? FAQ

▶ Solution Video

⌚ Have any Doubt ?



Number of productions remain after removal of ϵ -productions for the CFG.

$$\begin{aligned}
 S &\rightarrow AB \\
 A &\rightarrow aAA \mid \epsilon \\
 B &\rightarrow bBB \mid \epsilon
 \end{aligned}$$

10

Correct Option

Solution :

Given the grammar
 $S \rightarrow AB$
 $A \rightarrow aAA \mid \epsilon$
 $B \rightarrow bBB \mid \epsilon$
Nullable variables are $\{S, A, B\}$
So, after removal of ϵ -productions, grammar will be
 $S \rightarrow AB \mid A \mid B \mid \epsilon$
 $A \rightarrow aAA \mid aA \mid a$
 $B \rightarrow bBB \mid bB \mid b$
Here, number of productions is 10.

QUESTION ANALYTICS



Q. 29

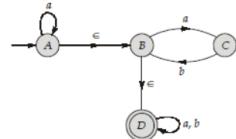
? FAQ

▶ Solution Video

⌚ Have any Doubt ?



Consider the following ϵ -NFA:



Number of final states in minimal DFA is _____.

1

Correct Option

Solution :

1
It is clear that it is accepting $(a+b)^*$
So only 1 state required

QUESTION ANALYTICS



Q. 30

? FAQ

▶ Solution Video

⌚ Have any Doubt ?



The length of the shortest string NOT in the language (over $\Sigma = \{a, b\}$) of the following regular expression $a^*b^*(ba)^*a^*$ is _____.

3

Correct Option

Solution :

3
R.E. = $a^*b^*(ba)^*a^*$
Length 0 is present as it accepts all length 1 strings are present (a, b) also aa, ab, ba, bb are present,
But ' bab ' is not present.
So it is 3.

QUESTION ANALYTICS





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Q. 31

? FAQ 

The following Context-Free Grammar (CFG):

$S \rightarrow aB \mid bA$
 $A \rightarrow a \mid aS \mid bAA$
 $B \rightarrow b \mid bS \mid aBB$

may generate(s)

- A Atleast one odd numbers of a's and odd numbers of b's.
- B Even numbers of a's and even numbers of b's.
- C Equal numbers of a's and b's.
- D Different numbers of a's and b's.

Correct Option

Correct Option

Correct Option

YOUR ANSWER - NA

CORRECT ANSWER - a,b,c

STATUS - SKIPPED

Solution :

(a, b, c)

The following Context-Free Grammar (CFG):

$S \rightarrow aB \mid bA$
 $A \rightarrow a \mid aS \mid bAA$
 $B \rightarrow b \mid bS \mid aBB$

will generate

- Odd numbers of a's and odd numbers of b's i.e. ab or ba.
- Even numbers of a's and even numbers of b's i.e. aabb or bbaa
- Equal numbers of a's and b's i.e. ab, ba bbbaa or aabb
- It will not generate different numbers of a's and b's i.e. abb or baa.

QUESTION ANALYTICS

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Q. 32

? FAQ  

Which of the following options is/are TRUE?

- A For every non-deterministic Turing machine, there exists an equivalent deterministic Turing machine.
- B Turing recognizable languages are closed under union and complementation.
- C Turing decidable languages are closed under intersection and complementation.
- D Turing recognizable languages are closed under union and intersection.

Correct Option

Correct Option

Correct Option

YOUR ANSWER - NA

CORRECT ANSWER - a,c,d

STATUS - SKIPPED

Solution :

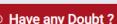
(a, c, d)

A recognizer of a language is a machine that recognizes that language.
 A decider of a language is a machine that decides that language.
 Both types of machine halt in the Accept state on strings that are in the language
 A decider also halts if the string is not in the language.
 A recognizer MAY or MAY NOT halt on strings that are not in the language.
 On all input:
 A decider MUST halt (in Accept or Reject state).
 A recognizer MAY or MAY NOT halt on some strings (Q: Which ones?)
 A language is Turing-decidable (or decidable) if some Turing machine decides it also known as Recursive Language.
 A language is Turing-recognizable if some Turing machine recognizes it also known as Recursively Enumerable Language.
 Recursive (Turing Decidable) languages are closed under following:
 Kleene star, concatenation, union, intersection, complement and set difference.
 Recursively enumerable language are closed under Kleene star, concatenation, union, intersection.
 They are NOT closed under complement or set difference.

QUESTION ANALYTICS

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Q. 33

? FAQ  

Which of the following statements is/are correct?

- A Every recursive language is recursively enumerable.
- B $L = \{0^n 1^n 0^n | n = 1, 2, 3, \dots\}$ is recursively enumerable.

Correct Option

Correct Option

C

Recursive languages are closed under intersection.

Correct Option

D

Recursive languages are not closed under intersection.

YOUR ANSWER - NA

CORRECT ANSWER - a,b,c

STATUS - SKIPPED

Solution :

(a, b, c)

Recursive languages are closed under intersection.

So, option (d) is false. All other seems correct.

QUESTION ANALYTICS 



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