CLASS TEST

S.No. : 01 SK_CS_ABC_130523

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THEORY OF COMPUTATION

COMPUTER SCIENCE & IT

Date of Test : 13/05/2023

ANSWER KEY

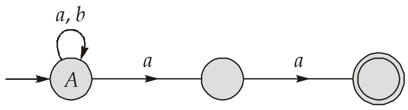
1.	(c)	7.	(c)	13.	(d)	19.	(b)	25.	(d)
2.	(d)	8.	(c)	14.	(b)	20.	(b)	26.	(d)
3.	(b)	9.	(d)	15.	(b)	21.	(d)	27.	(b)
4.	(c)	10.	(c)	16.	(a)	22.	(a)	28.	(a)
5.	(b)	11.	(c)	17.	(d)	23.	(b)	29.	(c)
6.	(d)	12.	(c)	18.	(c)	24.	(d)	30.	(c)

DETAILED EXPLANATIONS

1. **(c)**
The given DFA accepts all the strings that does not contain exactly two 0's.

2. **(d)**
A string is set to be accepted if on reading a string control of DFA reaches to some final state.
(a) Accepted
(b) Accepted
(c) Accepted
(d) Not accepted

3. **(b)**
These kinds of problems can be easily done if we take small instance and let the ideal to come out of it. The number of states for minimum NFA that ends with at least 2a's required 3 states.



Therefore, for ending with at least $n - 1$ a's requires n states.

4. **(c)**
If L is accepted by some DPDA then L must be deterministic context free language. The grammar that generates L will be deterministic context free grammar.
Also, A DCFG has an equivalent LR(0) grammar. All LR(K) grammars are unambiguous.
Hence Statement-1 is true. Statement-2 is true because PDA with final state has same expressive power as that of PDA with empty stack.

5. **(b)**
Σ^5 represents the strings of length exactly equals to 5 with all possible given symbols. Number of symbols are 4.
Thus,
$4 \times 4 \times 4 \times 4 \times 4$ (4 choices at every position)
at every position i.e. 1024

6. **(d)**
If we see the machine, so whenever we encounter.
$a \to$ Push x
then $b \to$ Push x
then $c \to$ Pop x
Now end of tape (#) and top of stack is \$ then go to final state.
So the machine accepts the language $\{a^i b^j c^{i+j} \mid i, j \geq 0\}$.
Hence, (d) is the correct answer.

7. **(c)**
Take a simple string i.e., generated by the grammar. Let us take x = 'a'. Now, make string xx = 'aa' and check if xx is generated by the grammar. The answer is NO.

If any string say for "x" generated by the grammar then "xx" is not generated by the same grammar.
Hence, option (c) is correct answer.

8. (c)
Language L_1 is regular since, it represents 0* 1*.
Language L_2 is CFL since, it involves one comparison. And, language L_3 is CSL since, it involves two comparison at a time.
Hence, option (a) is true since PDA can be used to recognize both L_1 and L_2 since they are regular and CFL respectively.
Clearly, option (c) is false.

9. (d)
q_1 shows $\in$ can be accepted. If we see the PDA, for first 'a', we push one zero into the stack and for each 'a' later on, we push two zeroes into stack.
Hence, $\{a^n b^{2n-1} \mid n \geq 1)\} \cup \in$ is correct expression.

10. (c)
Option (c) is the correct answer.

11. (c)
If we see the transition then we can observe things as follows :
(i) When we are at state 'S', and if we encounter 'a' then we are pushing two 'X'.
(ii) At state 'S', if we encounter input symbol 'b' and top of stack symbol is X, then we are deleting top of stock and move to state 't'.
(iii) At state 't', we do the same thing as shown in (ii) step and remain at 't' state. Similarly, if we observe 'c' at 't' state then we pop the stack symbol and move to new state and does the same if 'c' is encounter.
So, in conclusion for 'a' 2 'X' is pushed and for every 'b' or 'c' 1 'X' is popped.
So, language is $\{a^l b^m c^n \mid 2l = m + n\}$.
So, option (c) is correct.

12. (c)
The given machine is of PDA. So, surely it will be context free.
Now, the machine accepts the language
$$L = \{a^n b^n \mid n \geq 0\} \cup \{a^n \mid n \geq 0\}$$
So, option (c) is correct answer.

13. (d)
- Both A and B are not CFLs.
- Checking substring in B is not CFL. Because in PDA we uses single stack.

14. (b)
The intersection of two regular languages is infinite is decidable.
Whether a given context free language is regular is not decidable.
Whether a given grammar is context free is decidable.
Finiteness problem of regular language is decidable.

17. (d)

$$L(M) = \{w \mid n_a(w) = 0 \text{ or } n_a(w) \geq 4\}$$
$$\overline{L(M)} = L(\bar{M}) = \{w \mid 1 \leq n_a(w) \leq 3\}$$

So, option (d) is correct.

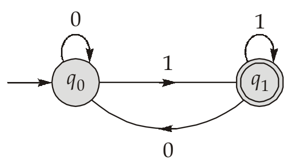
18. (c)

- L_1 is well known CSL.
- L_2 is a CFL as there is a CFG for L_2 given below.

$S \rightarrow A \mid B \mid AB \mid BA$
$A \rightarrow a \mid aAb \mid aAa \mid bAb \mid bAa$
$B \rightarrow b \mid aBa \mid aBb \mid bBb \mid bBa$

19. (b)

$L(r)$ represents set of all strings starting with 10.
$L(s)$ represents set of all strings ending with 1.
$L(r)^R$ represents set of all strings ending with 01.
Here, $L(r)^R \cup L(s)$ = set of all strings ending with 1.



21. (d)

$$L(G_1) \cap L(G_2) = \$^*$$

- Hence, it is regular. So, it satisfies pumping lemma as every regular language is also CFL. It is infinite hence Kleene's theorem also satisfies.
- Hence, option (d) is correct.

22. (a)

I and II always hold for DFA, as $L(M')$ is same as $[L(M)]^{\prime\phi}$. However, the same is not the true for NFA.

23. (b)

The Turing Machine T accepts the regular language corresponding to the regular expression $aa^* + bb^*$.

24. (d)

$$w = 11011$$
$$\text{Prefix }(w) = \{\in, 1, 11, 110, 1101, 11011\}$$
$$\text{Suffix }(w) = \{\in, 1, 11, 011, 1011, 11011\}$$
$$\text{Prefix }(w) \cap \text{Suffix }(w) = \{\in, 1, 11, \underbrace{11011}_{w}\}$$

So $\text{Prefix }(w) \cap \text{Suffix }(w) \neq \{\in, w\}$

Now,

$$\text{Prefix }(w) \cap \text{Suffix }(w) = \{\in, 1, 11, 110, 1101, 011, 1011, 11011\}$$
$$\text{Prefix }(w) \cup \text{Suffix }(w) \neq \text{Substring}(w)$$

because '101' substring not belong to Prefix $(w) \cup$ Suffix (w).

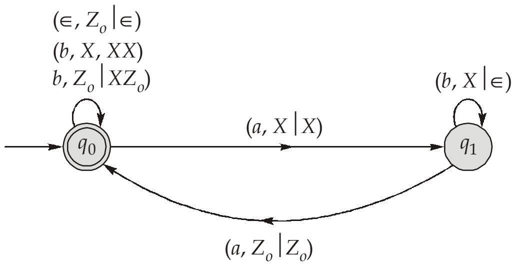
25. (d)

Option (d) correct matches.

26. (d)

- All I, II and III are regular.
- Try to avoid string matching by putting w as $\in$ and make x and y go to $(0 + 1)$. Therefore, we are shown that the subset itself is Σ^* and thus I and II are regular.
- Now in III, put w as $\in$ and make x^R and y^R go to Σ^* (Note that no string matching between x and y). Hence, III is regular.

27. (b)

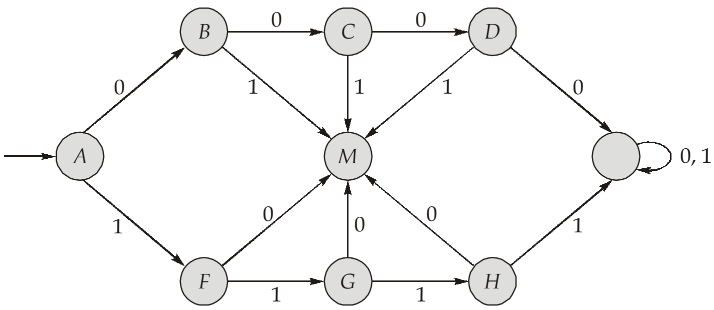


$$L = \{(b^n ab^n a)^m \mid m, n \geq 0\}$$

28. (a)

Since M is a TM that halts on all input. So, $L(M)$ is decidable. So, $L(M) \neq L'$. Hence, it will be recursive too.

29. (c)



The minimal DFA has 9 states.

30. (c)

- (a) is undecidable as this is non-trivial question on RE languages.
- (b) is ambiguous problem, well known undecidable.
- (c) is membership problem in CFG which is decidable.
- (d) is undecidable

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