CLASS TEST

S.No. : 01 JP_CS_08082022

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THEORY OF COMPUTATION

COMPUTER SCIENCE & IT

Date of Test : 08/08/2022

ANSWER KEY

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

1. **(d)**

2. **(d)**

You can get only 'b' from both.

3. **(a)**

Complement in CFL not closed but in DCFL it is closed.

L_1 is DCFL L_2 is also DCFL.

4. **(a)**

5. **(c)**

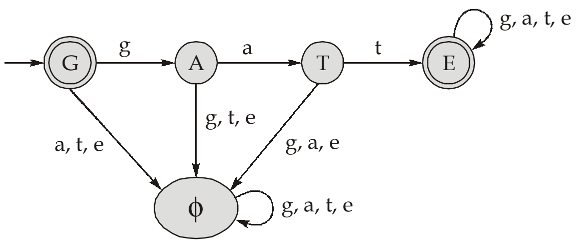
$$((11))^* (11111)^*)^* = (11 + 11111)^*$$

Which is the language corresponding to given grammar.

6. **(b)**

The given NFA accepts a language where each string starts with 'gat' [including Null string]

$\therefore$ Number of states required in DFA = 4 + 1 = 5 states



7. **(a)**

Simulate M on all strings of length atmost n for n steps and keep increasing n. We accept if the computation of M accepts some string.

8. **(a)**

Each rule $A \rightarrow BC$ increases the length of the string by 1, which gives $(n - 1)$ steps and exactly n rules $A \rightarrow a$ to convert variables into terminals.

Therefore exactly $2n - 1$ steps are required for CNF CFG.

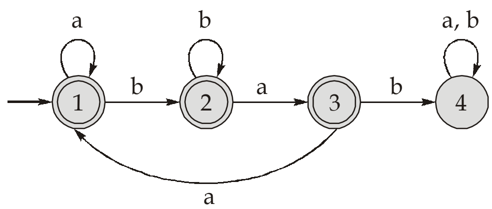
So option (a) is correct.

9. **(c)**

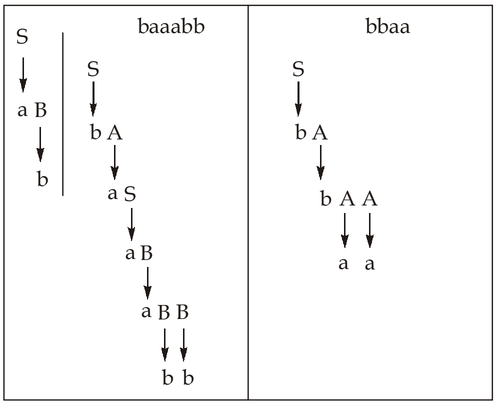
$$L_1 = \phi \rightarrow L_1^* = \{\varepsilon\} \text{ is finite}$$
$$L_1 = \{a\} \rightarrow L_1^* = \{a^*\} \text{ is infinite}$$

$\therefore$ L_2 need not be infinite

10. **(b)**



11. (c)



12. (b)

13. (c)

Clearly L_1, L_2 are DCFL's and hence CFL's.

$$L_1 \cap L_2 = \{a^i\, b^j\, c^k \mid i < j \text{ and } i < k\}$$

is not a CFL, since 2 comparisons must be made before acceptance and this is not possible using a single stack.

So, choice (c) is correct.

14. (b)

B1000B
1R000B
10R00B
100R0B
1000RB
1000LB
100L0B
10L00B
1L000B
L1000B

15. (d)

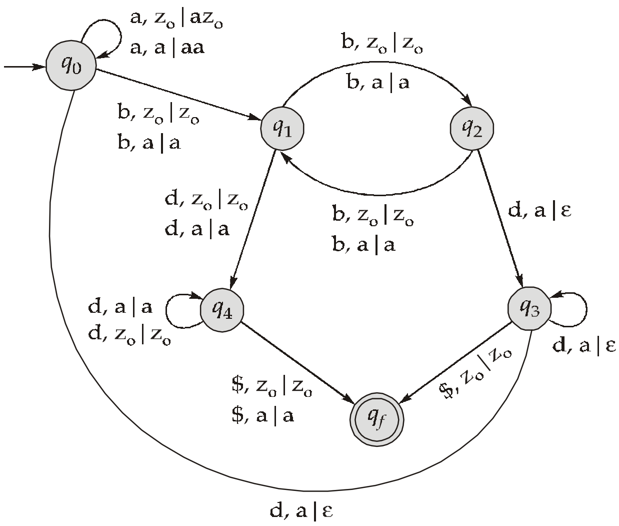
$S \to aSa \mid aAa$

$A \to bA \mid b$

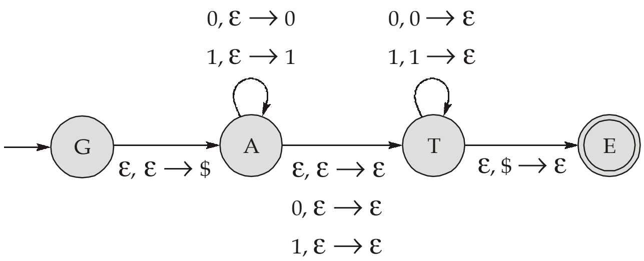
$$\begin{aligned} L(A) &= b^+ \\ L(S) &= a^n(ab^+a)a^n,\ n \geq 0 \\ &= a^{n+1}\, b^+\, a^{n+1} \\ &= a^m b^+ a^m \mid m > 0 \\ &= \{a^m b^n a^k \mid m = k,\ m, n, k > 0\} \end{aligned}$$

16. (c)

$$L = \{a^m b^n b^k d^l \mid \text{if } (n = k \text{ then } m = l\}$$
$$= \{a^m b^{2n} b^m\} \cup \{a^m b^{2n+1} b^k\}$$
$$= \text{DCFL} \cup \text{regular} = \text{DCFL}$$



17. (c)



G → A : Pushes "$" onto stack initially.
A → A : Pushes 0 for input 0 and Pushes 1 for input 1.
A → T : Moves A to T without reading an input (or)
R read 0 or 1 from input tape and does no operation on the stack.
T → T : Pop 0 for input 0 and Pop 1 for input 1.
T → E : Pop "$" from stack and reaches to final state [input string has completed reading]
∴ $L = \{\varepsilon, 0, 1, 00, 11, 000, 010, 101, 111, ...\}$
G is : $S \rightarrow 0S0 \mid 1S1 \mid 0 \mid 1 \mid \varepsilon$
So option (c) is correct.

18. (d)

(a) L is not recursive [and not REL], TM accepts a regular language is undecidable.
(b) L is not recursive [and not REL], TM accepts a regular language is undecidable.
(c) L is not recursive language [But REL], State entry problem is undecidable.
(d) L is recursive language
So option (d) is correct.

19. **(c)**

$$R = (a + \varepsilon)\,(bb^*a)^*$$

R generates the language that do not contain two or more consecutive a's and do not end with b.

20. **(b)**

B is Turing recognizable: Guess the 3 distinct inputs by non-deterministically for each TM and collect those TM's. A is complement of B, so A is not Turing recognizable.

Both A and B are undecidable languages, where A is non-REL and B is REL but not recursive.

21. **(c)**

$$\left.\begin{array}{l} S \rightarrow AAaSb \mid \varepsilon \\ A \rightarrow a \mid \varepsilon \end{array}\right\} \cong S \rightarrow aSb \mid aaSb \mid aaaSb \mid \varepsilon$$

$$L(G) = \{a^m b^n \mid n \le m \le 3n\}$$

22. **(b)**

$$\begin{aligned} L_2 - L_1 &= L_2 \cap \overline{L_1} \\ &= \text{REL} \cap \overline{\text{RECURSIVE}} \\ &= \text{REL} \cap \text{RECURSIVE} \\ &= \text{REL} \end{aligned}$$

$\therefore$ $L_2 - L_1$ is Recursive Enumerable Language (REL).

23. **(c)**

$\overline{L}$ has every even length string and it contain all odd length strings which are not in the form of $w\,x\,w^R$. [It can be implemented by selecting non-deterministic mismatch symbols of w and w^R]

$\overline{L}$ is CFL but not DCFL.

24. **(d)**

The language accepted by the PDA with finite stack is always regular language. Regular language may be finite or infinite.

$\therefore$ Option (d) is correct.

25. **(c)**

$$L_1.L_2 = (\text{Regular}) \;.\; (\text{CSL})$$

L_2 is $a^n\,b^n\,c^n$, but L_1 can be any regular language

Case 1: If $L_1 = \phi$,

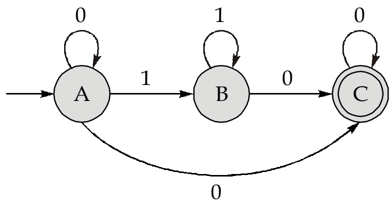
$\Rightarrow$ $L_1.L_2 = \phi.\ \{a^n\,b^n\,c^n\} = \phi$ is regular

Case 2: If $L_1 = \{\varepsilon\}$

$\Rightarrow$ $L_1.L_2 = \{\varepsilon\}.\ \{a^n\,b^n\,c^n\} = \{a^n\,b^n\,c^n\}$ is CSL

$L_1.L_2$ is always CSL but it may or may not be regular.

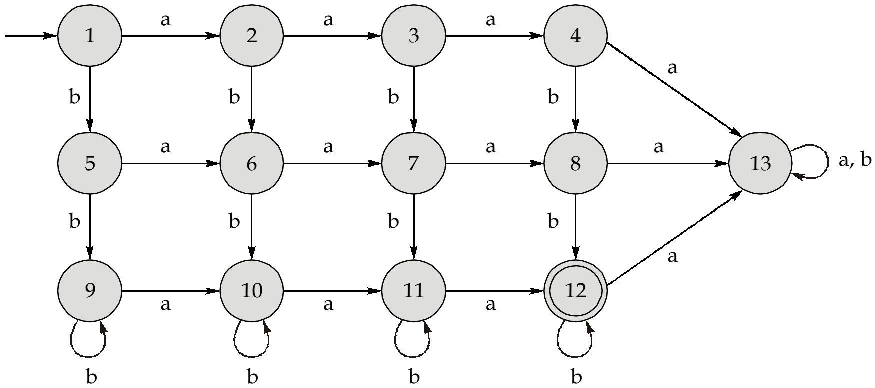
26. (c)



R.E. = $0^*(11^*\,0 + 0)\,0^*$
= $0^*((11^* + \varepsilon)\,0)\,0^*$
= $0^*\,1^*\,0\,0^*$
= $0^*\,1^*\,0^*\,0$

So, option (c) is correct.

27. (b)



Number of states = 13 states

28. (b)

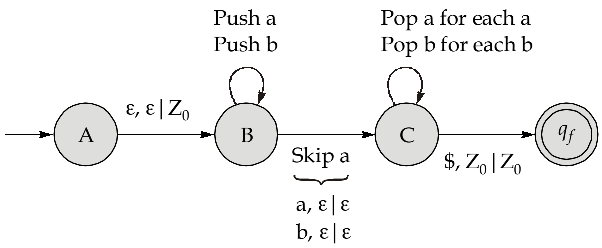
(a) Regular language: 1 [(0 + 1) (0 + 1)]*
(b) Non regular language (finding middle symbol is not possible)
(c) Regular language: [(0 + 1) (0 + 1)]* 1

29. (d)

All given languages are DCFL.

(a) $\{w \mid \#_0(w)! = \#_1(w),\ w \in (0+1)^*\}$ is DCFL.
(b) $\{xwx \mid x \in (0+1),\ w \in (0+1)^*, \#_0(w) = \#_1(w)\}$ is DCFL.
(c) If string starts with 1 then it accepts 0^n1^n as next symbols of the string. If string starts with 11 then it accepts 0^K1^{2K} as next symbols of the string, which is also DCFL.

30. (c)



$$L = \left\{ \underbrace{w}_{\text{push}} \ \underbrace{x}_{\text{skip}} \ \underbrace{w^R}_{\text{pop}} \ \middle| \ w \in (a+b)^* \ x \in (a+b) \right\}$$

∴ Option (c) is correct.

■■■■