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SFA Test 1

Q1)

c) <u>Regular Expression</u>:- Patterns formed only using symbols $\varepsilon, \phi, +, \cdot, *$ and elements of Σ are known as regular expressions

<u>Eg</u>:- Let $\Sigma = \{a, b\}$

$a^* + (bb)^*$ → regular expression

a) <u>DFA</u>:- Deterministic Finite Automata is a structure $M = (Q, \Sigma, \delta, s, F)$ ~~sot~~ where Q is the set of states possible, Σ is the alphabet of possible inputs, s is the start state, F is the final states and δ is a function from $Q \times \Sigma$ to Q which moves from one state to other in response to an input.

<u>Eg</u>:-

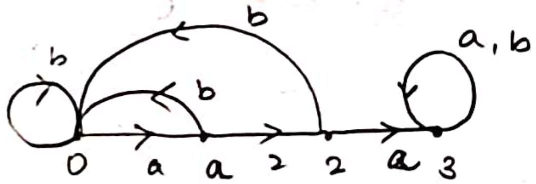
	a	b
s → 0	1	0
1	2	0
2	3	0
F → 3	3	3

A = strings with 3 continuous a's (regular language)

$\Sigma = \{a, b\}$

F = 3

S = 0



b) <u>NFA</u>:- Non Deterministic finite Automata is a ~~str~~ structure $N = (Q, \Sigma, \Delta, s, F)$ ~~such that~~ where Q is the set of possible states, Σ is the alphabet of possible inputs, s is the set of startes, F is the set of final states and Δ is a function from $Q \times \Sigma$ to 2^Q which gives the possible states to move to from a given state in response to an input

<u>Eg</u>:- A = strings with 1 on 2nd position from right

	0	1
ϕ	ϕ	ϕ
s → 0	0	1, 0
Final → 1	1	1

e.) CFL :- context free language is the language generated by context free grammar G and is denoted by L(G).

Eg :- $\{a^n b^n \mid n \geq 0\}$

d) NPDA :- Non Deterministic Push Down Automata (N PDA) is a type of NFA which is associated with stack. NPDA is a structure of the form $N = (Q, \Sigma, \Gamma, \delta, s, \perp, F)$ where Q is the set of all possible states, Σ is the alphabet of inputs, s is the start state, F is the Final state, Γ is the alphabet of stack. $\perp$ is the starting stack, ~~of~~ and δ is the transition function

Q2) a) Pumping lemma

Let A be a regular language $\exists$ $k \geq 0$ such that for string $xyz \in A$, $|y| \geq k$, there exists u, v, w such that $v \neq \varepsilon$, $y = uvw$ and $\forall i \geq 0$, $xuv^iwz \in A$

Pumping lemma is a necessary condition and not sufficient condition. Hence non-regular languages can also satisfy pumping lemma

We can only prove that, if a language does not satisfy pumping lemma, it is non regular

Informal meaning of pumping lemma:-

If we pump v even ∞ times xuv^iwz still stays in A.

Q2) b)

Pumping lemma For CFL

Let A be any CFL, $\exists\ k \geq 0$ such that for all $z \in A$, $|z| \geq k$

Then we can write $z = uvwxy$, st $vx \notin \varepsilon$ and $|vwx| \leq k$. Also, $\forall i \geq 0$ $uv^iwx^iy \in A$

Proving $a^n b^n c^n$ is not CFL using pumping lemma

Let us assume A is a CFL i.e A satisfies pumping lemma. Let $z = a^n b^n c^n$, As $|z| \geq n$ and $z \in L$, there exist

$z = uvwxy \Rightarrow |vwx|$ has to be $\leq n$ &

$|vx| \geq 1$ as $vx \notin \varepsilon$

$\forall i \geq 0$, $uv^i w x^i y \in A$

Let us take the case where uvw consists of only "a"

~~Let~~ when $i = 0$, $uv^iwx^iy \notin A$

This is a contradiction.

Hence, A is not a CFL (proved using pumping lemma)

Q3) a) S is a regular language and ~~a~~ a CFL too. if L is a regular language & ~~not~~ non deterministic ~~F~~ CFL
If L is deterministic CFL, S is not a CFL.

Proof 1:-

L is a regular language and let M be the automata that accepts the strings of L.

Consider automata N which accepts the start states of M and states with accept states of M.

The transition b/w states of N is opp. to that of M.

∴ N accepts the reverse strings of L.

Thus S is regular.

Proof 2:-

We know that $L = L(G)$ where G is CFG.

let $G = (V, T, P, S)$.

Construct $H = (V, T, P', S)$ | here P' is reverse of P for each production.

i.e $A \to a \Rightarrow$ production of G

$A \to a' \Rightarrow$ production of H

a' is reverse of a

Then $S = S(\#)$

Thus S is a CFL