1.Define Pushdown Automata.

A pushdown Automata M is a system (Q, Σ, Ґ ,δ ,q0, Z0,F) where

Q is a finite set of states.

Σ is an alphabet called the input alphabet.

Ґ is an alphabet called stack alphabet. q0 in Q is called initial state.

Zo in Ґ is start symbol in stack. F is the set of final states.

δ is a mapping from Q X (Σ U {Є}) X Ґ to finite subsets of Q X Ґ *.

2.Compare NFA and PDA.

NFA	PDA
1.The language accepted by NFA is the regular language.	The language accepted by PDA is Context free language.
2.NFA has no memory.	PDA is essentially an NFA with a stack(memory).
3. It can store only limited amount of information.	It stores unbounded limit of information.

4.A language/string is accepted only by reaching the final state.	It accepts a language either by empty Stack or by reaching a final state.

3.Specify the two types of moves in PDA.

The move dependent on the input symbol(a) scanned is:

$\delta(q,a,Z) = \{ (p1, \gamma 1), (p2,\gamma 2),\ldots\ldots..(pm,\gamma m) \}$

where q qnd p are states , a is in Σ ,Z is a stack symbol and γi is in Γ*. PDA is in state q , with input symbol a and Z the top symbol on state enter state pi Replace symbol Z by string γi.

The move independent on input symbol is (Є-move):

$\delta(q,Є,Z)= \{ (p1,\gamma 1), (p2,\gamma 2),\ldots\ldots\ldots\ldots(pm,\gamma m) \}$.

Is that PDA is in state q , independent of input symbol being scanned and with

Z the top symbol on the stack enter a state pi and replace Z by γi.

4.What are the different types of language acceptances by a PDA and define them.

For a PDA M=(Q, Σ ,Γ ,δ ,q0 ,Z0 ,F) we define : Language accepted by final state**L(M)** as:

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{ w | (q0 , w , Z0) |--- (p, Є , γ) for some p in F and γ in Γ * }.

Language accepted by empty / null stack **N(M)** is:

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{ w | (q0,w ,Z0) |----(p, Є, Є) for some p in Q}.

5. Is it true that the language accepted by a PDA by empty stack and final states are different languages.

No, because the languages accepted by PDA ‘s by final state are exactly the languages accepted by PDA’s by empty stack.

6. Define Deterministic PDA.

A PDA M =(Q, Σ ,Ґ ,δ ,q0 ,Z0 ,F) is deterministic if:

For each q in Q and Z in Ґ , whenever δ(q,Є,Z) is nonempty ,then

δ(q,a,Z) is empty for all a in Σ.

For no q in Q , Z in Ґ , and a in Σ U { Є} does δ(q,a,Z) contains more than one element.

(Eg): The PDA accepting {wcwR | w in (0+1) * }.

7.What is the significance of PDA?

Finite Automata is used to model regular expression and cannot be used to represent non regular languages. Thus to model a context free language, a Pushdown

Automata is used.

8. When is a string accepted by a PDA?

The input string is accepted by the PDA if: The final state is reached .

The stack is empty.

9. Give examples of languages handled by PDA.

(1) L={ anbn | n>=0 },here n is unbounded , hence counting cannot be done by finite memory. So we require a PDA ,a machine that can count without limit.

(2) L= { wwR | w Є {a,b}* } , to handle this language we need unlimited counting capability .

10. Is NPDA (Nondeterministic PDA) and DPDA (Deterministic PDA)equivalent?

The languages accepted by NPDA and DPDA are not equivalent. For example: wwR is accepted by NPDA and not by any DPDA.

11. State the equivalence of acceptance by final state and empty stack.

If L = L(M2) for some PDA M2 , then L = N(M1) for some PDA M1. If L = N(M1) for some PDA M1 ,then L = L(M2) for some PDA M2.

where L(M) = language accepted by PDA by reaching a final state.

N(M) = language accepted by PDA by empty stack.

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12. State the equivalence of PDA and CFL.

If L is a context free language, then there exists a PDA M such that

L=N(M).

If L is N(M) for some PDA m, then L is a context free language.

13. What are the closure properties of CFL?

CFL are closed under union, concatenation and Kleene closure. CFL are closed under substitution , homomorphism.

CFL are not closed under intersection , complementation.

Closure properties of CFL's are used to prove that certain languages are not context free.

14. State the pumping lemma for CFLs.

Let L be any CFL. Then there is a constant n, depending only on L, such that if z is in L and |z| >=n, then z=uvwxy such that :

(i) |vx| >=1

(ii) |vwx| <=n and

(iii) for all i>=0 uviwxiy is in L.

15. What is the main application of pumping lemma in CFLs?

The pumping lemma can be used to prove a variety of languages are not context free . Some examples are:

L1 ={ aibici | i>=1} is not a CFL.

L2= { aibjcidj | i>=1 and J>=1 } is not a CFL.

16. Give an example of Deterministic CFL.

The language L={anbn : n>=0} is a deterministic CFL

17. What are the properties of CFL?

Let G=(V,T,P,S) be a CFG

The fanout of G , Φ(G) is largest number of symbols on the RHS of

any rule in R.

The height of the parse tree is the length of the longest path from the root to some leaf.

18. Compare NPDA and DPDA.

NPDA	DPDA
1. NPDA is the standard PDA used in automata theory.	1. The standard PDA in practical situation is DPDA.
2. Every PDA is NPDA unless otherwise specified.	2. The PDA is deterministic in the sense ,that at most one move is possible from any ID.

19. What are the components of PDA ?

The PDA usually consists of four components: A control unit.

A Read Unit. An input tape.

A Memory unit.

20. What is the informal definition of PDA?

A PDA is a computational machine to recognize a Context free language. Computational power of PDA is between Finite automaton and Turing machines. The

PDA has a finite control , and the memory is organized as a stack.