# UNIT-I AUTOMATA

## PART-A(2-MARKS)

1 What is Computation? and Write short notes on TOC.
2 Define Automaton
3 Define Inductive and Deductive proof
4 Define hypothesis.
5 What is the principle of Mathematical Induction?
6 List any four ways of theorem proving.
7 What is structural Induction?
8 Write the central concepts of Automata Theory
9 Define Language and Give example.
10 Define transition diagram.
11 What is Finite Automata and explain the applications of Finite automata.
12 Define the languages described by NFA and DFA.
13 Give the DFA accepting the language over the alphabet 0,1 that have the set of all strings beginning with 101.
14 Give the DFA accepting the language over the alphabet 0,1 that have the set of all strings containing 1101 as a substring.

15 Give the DFA accepting the language over the alphabet 0,1 that have the set of all strings ending in 00.
16 Give the DFA accepting the language over the alphabet 0,1 that have the set of all strings with three consecutive 0's.
17. Give the DFA accepting the language over the alphabet 0,1 that have the set of all strings with 011 as a substring.
18 Give the DFA accepting the language over the alphabet 0,1 that have the set of all strings whose $10_{th}$ symbol from the right end is 1.
19 Construct a DFA for the following
a) All stings that contain exactly 4 zeros
b) All strings that don't contain the substring 110.
20 Give the DFA accepting the language over the alphabet 0,1 that have the set of all strings that either begins or end(or both) with 01.
21 Give the DFA accepting the language over the alphabet 0,1 that have the set of all strings such that the no of zero's is divisible by 5 and the no of 1's is divisible by 3.
22 Difference between DFA and NFA
23 Define NFA.
24 Define the language of NFA.
25. Is it true that the language accepted by any NFA is different from the regular language? Justify your Answer.
26. Define ε-NFA.
27. Define ε closure.
28. Find the εclosure for each state from the following automata.

## Part B

1. a) If L is accepted by an NFA with ε-transition then show that L is accepted by an NFA without ε-transition.

b) Construct a DFA equivalent to the NFA.

$M=(\{p,q,r\},\{0,1\}, \delta,p,\{q,s\})$

Where δis defined in the following table.

| | 0 | 1 |
|---|---|---|
| p | {q,s} | {q} |
| q | {r} | {q,r} |
| r | {s} | {p} |
| s | - | {p} |

2. a)Show that the set $L=\{a_n b_n/n>=1\}$ is not a regular. (6) b)Construct a DFA equivalent to the NFA given below: (10)

| | 0 | 1 |
|---|---|---|
| p | {p,q} | P |
| q | r | R |
| r | s | - |
| s | s | S |

3. a)Check whether the language $L=(0_n 1_n/n>=1)$ is regular or not? Justify your answer.

b) Let L be a set accepted by a NFA then show that there exists aDFA that accepts L.

4.

(i) **Convert the following NFA to a DFA** **(10)**

| δ | a | b |
|---|---|---|
| p | $\{p\}$ | $\{p,q\}$ |
| q | $\{r\}$ | $\{r\}$ |
| r | $\{\phi\}$ | $\{\phi\}$ |

(ii) **Discuss on the relation between DFA and minimal DFA.** **(6)**

5. a) Construct a NDFA accepting all string in $\{a,b\}_+$ with either two consecutive a's or two consecutive b's.

b) Give the DFA accepting the following language:set of all strings beginning with a 1 that when interpretedas a binary integer is a multiple of 5.

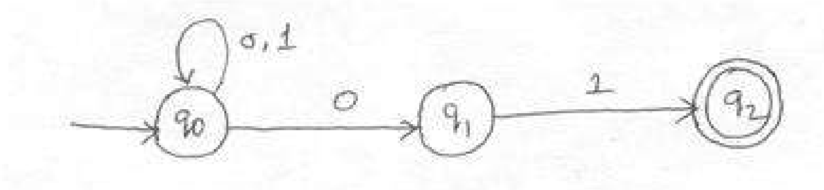
6. Draw the NFA to accept the following languages.

(i) Set of Strings over alphabet {0,1,…….9} such that the final digit has appeared before. (8)

(ii)Set of strings of 0's and 1's such that there are two 0's separated by a number of positions that is a multiple of 4.

7.a)Let L be a set accepted by an NFA.Then prove that there exists a deterministic finite automaton that accepts L.Is the converse true? Justify your answer. (10)

b)Construct DFA equivalent to the NFA given below: (6)




8.a) Prove that a language L is accepted by some ε-NFA if and only if L is accepted by some DFA. (8)

b) Consider the following ε-NFA.Compute the ε-closure of each state and find it's equivalent DFA. (8)

| | ε | A | b | C |
|---|---|---|---|---|
| p | {q} | {p} | Φ | Φ |
| q | {r} | ф | {q} | Φ |
| *r | Φ | ф | ф | {r} |

9.a) Prove that a language L is accepted by some DFA if L is accepted by some NFA.

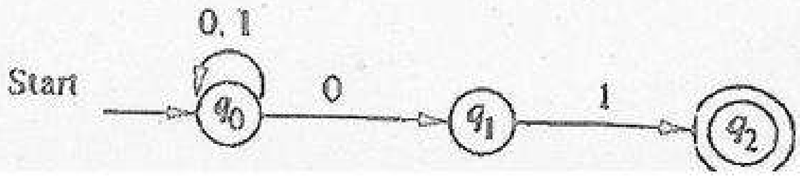
b) Convert the following NFA to it's equivalent DFA

| | 0 | 1 |
|---|---|---|
| p | {p,q} | {p} |
| q | {r} | {r} |
| r | {s} | ϕ |
| *s | {s} | {s} |

10.a) Explain the construction of NFA with εtransition from any given regular expression.

b) Let $A=(Q,\Sigma, \delta, q_0, \{q_f\})$ be a DFA and suppose that for all a in $\Sigma$ we have $\delta(q_0, a)= \delta(q_f, a)$. Show that if x is a non empty string in L(A),then for all $k>0$, $x^k$ is also in L(A).

11. Explain the steps in conversion of NFA to DEA. Convert the following NFA to DFA. (8)




12.Convert the following ε-NFA to DFA

| states | ε | a | b | C |
|---|---|---|---|---|
| p | Φ | {p} | {q} | {r} |
| q | {p} | {q} | {r} | Φ |
| *r | {q} | {r} | ϕ | {p} |

13.Prove that there exists a DFA for every ε-NFA

14.

(i) Prove the following by the principle of induction

$$\sum_{k=1}^{n} k^2 = \frac{n(n+1)\ (2n+1)}{6}. \qquad (6)$$

(ii) For the finite state machine M given in the following table, test whether the strings 101101,11111 are accepted by M. (4)

| State | Input 0 | Input 1 |
|---|---|---|
| $\rightarrow q_0$ | $q_0$ | $q_1$ |
| $q_1$ | $q_3$ | $q_0$ |
| $q_2$ | $q_0$ | $q_3$ |
| $q_3$ | $q_1$ | $q_2$ |

(iii) Construct a DFA that accepts all the strings on $\{0,1\}$ except those containing the substring 101. (6)

15. Construct a non-deterministic finite automation accepting the same set of strings over {a, b} ending in aba. Use it to construct a DFA accepting the same set of strings. (10)

16.Prove that for all $n\geq0$ $\sum i^2 = n(n+1)(2n+1) / 6$ by the Mathematical induction.

17.Prove that all Natural numbers of the form $n^3+2n$ are divisible by 3 using Prniciple of Induction.

18.Show that $2^n > n^3$ for $n\geq0$ by mathematical induction

19.1+2+3+……….+n = n(n+1)/2

## UNIT-II REGULAR EXPRESSIONS AND LANGUAGES

## PART-A

1 Define Regular expression. Give an example.
2 What are the operators of RE.
3 Write short notes on precedence of RE operators.
Write Regular Expression for the language that have the set of strings over {a,b,c} containing at least one a and at least one b.
4 Write Regular Expression for the language that have the set of all strings of 0’s and 1’s whose $10_{th}$ symbol from the right end is 1.
5 Write Regular Expression for the language that has the set of all strings of 0’s and 1’s with at most one pair of consecutive 1’s.
6 Write Regular Expression for the language that have the set of all strings of 0’s and 1’s such that every pair of adjacent 0’s appears before any pair of adjacent

1's.

7 Write Regular Expression for the language that have the set of all strings of 0's and 1's whose no of 0's is divisible by 5.

8 Write Regular Expression for the language that has the set of all strings of 0's and 1's not containing 101 as a substring.

9 Write Regular Expression for the language that have theset of all strings of 0's and 1's such that no prefix has two more 0's than 1's, not two more 1's than 0's.

10. Write Regular Expression for the language that have the set of all strings of 0's and 1's whose no of 0's is divisible by 5 and no of 1's is even.

11. Give English descriptions of the languages of the regular expression (1+ ε)(00*1)*0*.

12. Give English descriptions of the languages of the regular expression (0*1*)*000(0+1)*.

13. Give English descriptions of the languages of the regular expression (0+10)*1*.

14. Convert the following RE to ε-NFA.01*.

15. State the pumping lemma for Regular languages.

16. What are the application of pumping language? And State the closure properties of Regular language.

17 Prove that if L and M are regular languages then so is LUM.

18 What do you mean by Homomorphism?

19 Suppose H is the homomorphism from the alphabets {0,1,2} to the alphabets {a,b} defined by h(0)=a h(1)=ab h(2)=ba. What is h(0120) and h(21120).

20. Suppose H is the homomorphism from the alphabets {0,1,2} to the alphabets {a,b} defined by h(0)=a h(1)=ab h(2)=ba. If L is the language L(01*2) what is h(L).

21. Let R be any set of regular languages is U Ri regular?Prove it.

22. Show that the compliment of regular language is also regular.

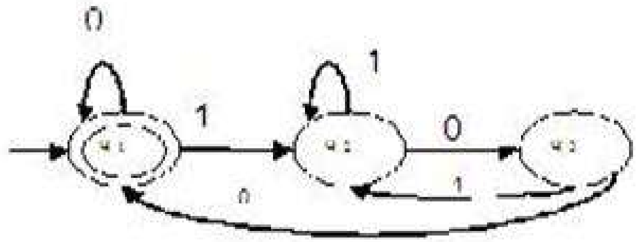
23 . What is meant by equivalent states in DFA.

24. Define ARDEN'S THEOREM

## PART-B

1.a)Construct an NFA equivalent to (0+1)*(00+11)

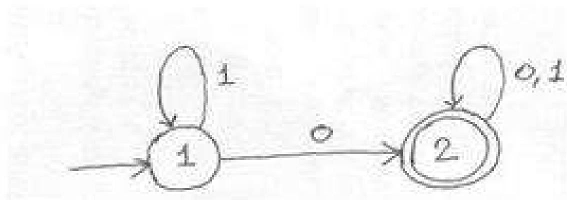
2.a)Construct a Regular expression corresponding to the state diagram given in the following figure.



b) Show that the set $E=\{0^i 1^i | i>=1\}$ is not Regular. (6)

3.a)Construct an NFA equivalent to the regular expression (0+1)*(00+11)(0+1)*.

b)Obtain the regular expression that denotes the language accepted by the following DFA.

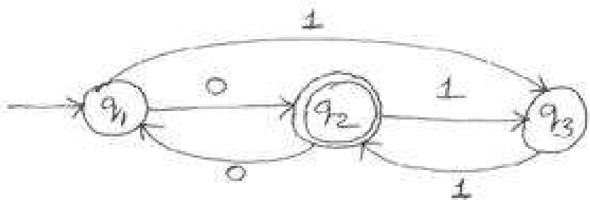


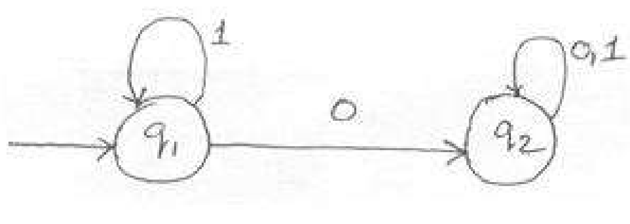

4.a)Construct an NFA equivalent to the regular expression ((0+1)(0+1)(0+1))*

b)Construct an NFA equivalent to 10+(0+11)0*1

5.a)Obtain the regular expression denoting the language accepted by the following DFA (8)

b)Obtain the regular expression denoting the language accepted by the following DFA by using the formula $Rij^{k}$




6. a)Show that every set accepted by a DFA is denoted by a regular Expression

b)Construct an NFA equivalent to the following regular expression01*+1.

7. a)Define a Regular set using pumping lemma Show that the language L={0i2 / i is an integer,i>=1} is not regular

b)Construct an NFA equivalent to the regular expression 10+(0+11)0*1

8. a) Show that the set L={O $^{n2/n}$ is an integer,n>=1} is not regular.

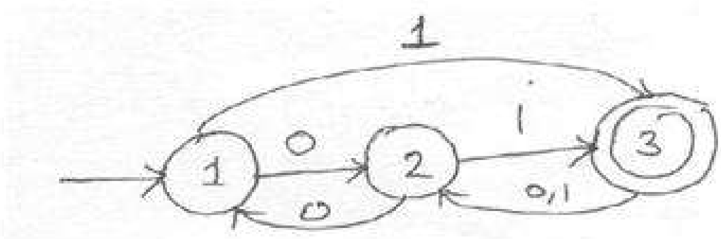
b)Construct an NFA equivalent to the following regular expression ((10)+(0+1) $^{*}$ 01. (10) 9.a)Prove that if L=L(A) for some DFA A,then there is a regular expression R such that L=L(R).

b) Show that the language {0p,p is prime} is not regular.

10.Find whether the following languages are regular or not.

(i) L={w ε{a,b}|w=w $^{R}$}.
(ii) L={0 $^{n}1^{m}2^{n+m}$,n,m>=1}
(iii) L={1k|k=n2,n>=1} . (4)
(iv) L1/L2={x | for some y εL2,xy εL1},where L1 and L2 are any two languages and L1/L2 is the quotient of L1 and L2.

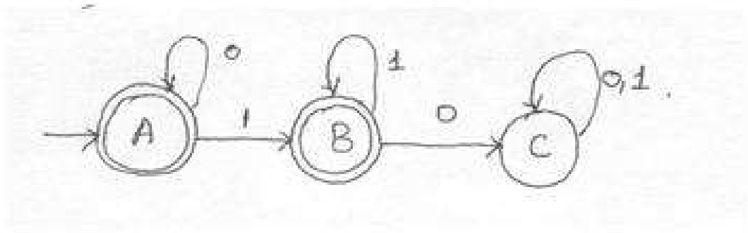
11.a) Find the regular expression for the set of all strings denoted by R213 from the deterministic finite automata given below:



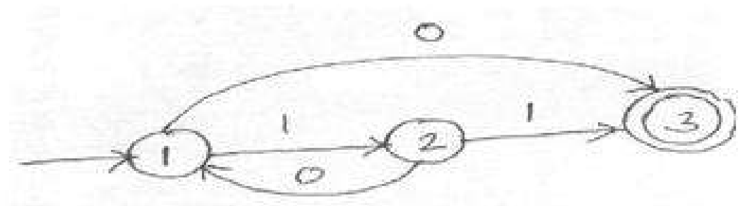

b)Verify whether the finite automata M1 and M2 given below are equivalent over {a,b}.

12.a)Construct transition diagram of a finite automaton corresponding to the regular expression (ab+c $^{*}$)$^{*}$b.

13.a)Find the regular expression corresponding to the finite automaton given below.




b)Find the regular expression for the set of all strings denoted by $R^{2}_{23}$ from the deterministic finite automata given below.




14.a) Find whether the languages {ww,w is in (1+0)*} and $\{1^k \mid k=n^2, n>=1\}$ are regular or not.

b) Show that the regular languages are closed under intersectionand reversal.

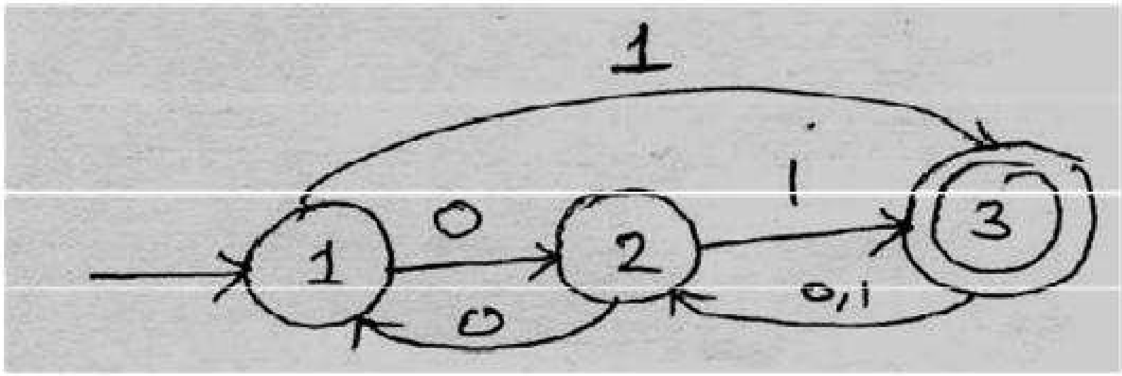
15. If L = L(A) for some DFA A,then there is a regular expression R such that L=L(R).

16.Every language defined by a regular expression is also defined by a Finite automaton. (Or) Let r be a regular expression is also defined by a finite automaton.

17. Convert the regular expression (0+1)* 1 (0+1) to an ε NFA

18.Explain in detail of closure properties of Regular languages

19. Find the regular expression for the set of all strings denoted by $R^2$ 13 from the deterministic finite automata given below: (16)

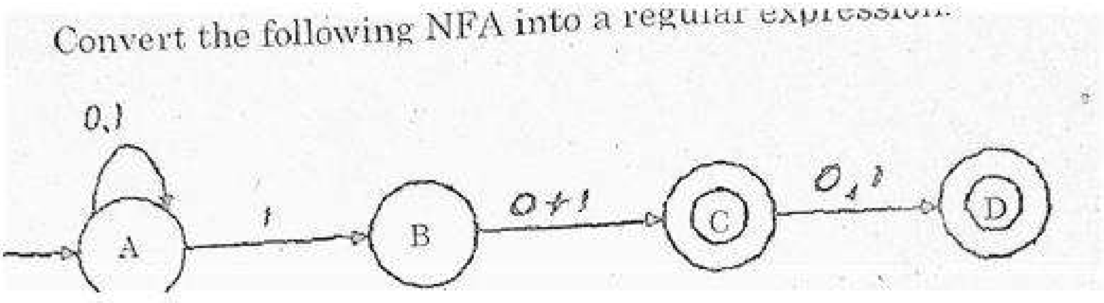



(OR)

b) i) Show that the regular languages are closed under intersectionand reversal. (8)

ii) Show that the set L={O$^{n2/n}$ is an integer,n>=1} is not regular. (8)

20.



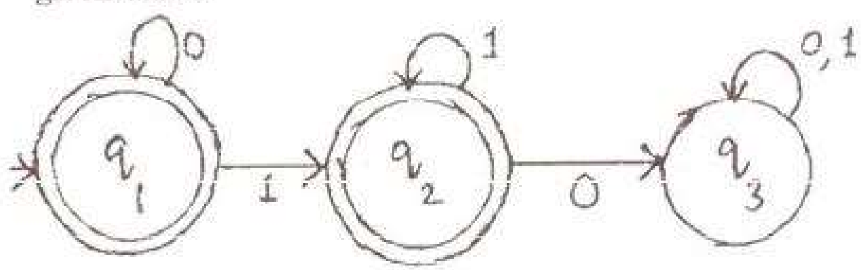
21.

Construct a minimum state automaton equivalent to a given automaton M whose transition table is given below.

| State | Input | |
|---|---|---|
| | a | b |
| $\rightarrow q_0$ | $q_0$ | $q_3$ |
| $q_1$ | $q_2$ | $q_5$ |
| $q_2$ | $q_3$ | $q_4$ |
| $q_3$ | $q_0$ | $q_5$ |
| $q_4$ | $q_0$ | $q_6$ |
| $q_5$ | $q_1$ | $q_4$ |
| $q_6$ | $q_1$ | $q_3$ |

(8)

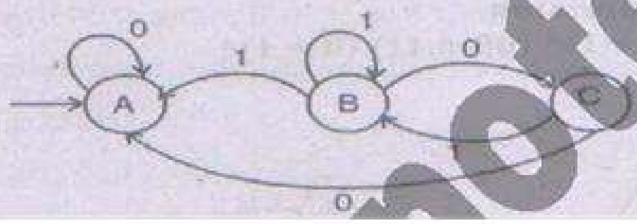
Find the regular expression corresponding to the finite automaton given below. (8)



22.

(i) Construct a Regular expression for the following DFA using Kleene's theorem. (10)

| | 0 | 1 |
|---|---|---|
| →*A | A | B |
| B | C | B |
| C | A | B |




23.

(i) Construct a minimized automata for the following automata to define the same language. (10)

| | a | b |
|---|---|---|
| $\rightarrow q_0$ | $q_1$ | $q_0$ |
| $q_1$ | $q_0$ | $q_2$ |
| $q_2$ | $q_3$ | $q_1$ |
| $*q_3$ | $q_3$ | $q_0$ |
| $q_4$ | $q_3$ | $q_5$ |
| $q_5$ | $q_6$ | $q_4$ |
| $q_6$ | $q_5$ | $q_6$ |
| $q_7$ | $q_6$ | $q_3$ |

## UNIT-III CONTEXT FREE GRAMMARS AND LANGUAGES

## PART-A

1. Define CFG.2.Find L(G)where G=({S},{0,1},{S->0S1,S->ε},S).
2. Define derivation tree for a CFG(or)Define parse tree.
3. Construct the context-free grammar representing the set of palindromes over $(0+1)^*$
4. construct a context free Grammar for the given expression (a+b) $(a+b+0+1)^*$
5. Consnruct a CFG for the language L = { $a^n$ / n is odd}
6. Construct the CFG for generating the language L={$a^n b^n$/n>=1}.
7. Let G be the grammar S->aB/bA,A->a/aS/bAA,B->b/bS/aBB.for the string

aaabbabbba find the left most derivation.

8. Let G be the grammar S->aB/bA,A->a/aS/bAA,B->b/bS/aBB.obtain parse tree for the string aaabbabbba.

9. For the grammar S->aCa,C->aCa/b.Find L(G).

10. Show that id+id*id can be generated by two distinct leftmost derivation in the grammar E->E+E | E*E | (E) | id .

11. For the grammar S->A1B,A->0A | ε, B-> 0B | 1B| ε,give leftmost and rightmost derivations for the string 00101.

12. Find the language generated by the CFG G=({S},{0,1},{S->0/1/ ε, S->0S0/1S1},S).

13. obtain the derivation tree for the grammar G=({S,A},{a,b},P,S) where P consist of S->aAS / a, A->SbA / SS / ba.

14.Consider the alphabet ∑={a,b,(,),+,*, ., ε} .Construct the context free grammar that generates all strings in ∑* that are regular expression over the alphabet {a,b}.

15 Write the CFG to generate the set $\{a_m b_n c_p \mid m + n=p \text{ and } p>=1\}$.

16 Construct a derivation tree for the string 0011000 using the grammar
S->A0S |0 | SS , A-> S1A | 10.

17 Give an example for a context free grammar.

18 Let the production of the grammar be S-> 0B | 1A, A-> 0 | 0S | 1AA, B-> 1|1S | 0BB.for the string 0110 find the right most derivation.

19 What is the disadvantages of unambiguous parse tree. Give an example.

20 Give an example of PDA.

21. Define the acceptance of a PDA by empty stack. Is it true that the language accepted by a PDA by empty stack or by that of final state are different languages.

22. What is additional featurePDA has when compared with NFA? Is PDA superior over NFA in the sense of language acceptance? Justify your answer.

23. Explain what actions take place in the PDA by the transitions (moves) $\delta(q,a,Z)=\{(p1,\gamma1),(p2, \gamma2),\ldots(pm, \gamma m)\}$ and $\delta(q, \varepsilon,Z)= \{(p1,\gamma1),(p2, \gamma2),\ldots(pm,\gamma m)\}$.

19. What are the different ways in which a PDA accepts the language? Define them. Is a true that non deterministic PDA is more powerful than that of deterministic PDA? Justify your answer.

20. Explain acceptance of PDA with empty stack.

21. Is it true that deterministic push down automata and non deterministic push down automata are equivalent in the sense of language of acceptances? Justify your answer.

22. Define instantaneous description of a PDA.

23. Give the formal definition of a PDA.

24. Define the languages generated by a PDA using final state of the PDA and empty stack of that PDA.

25. Define the language generated by a PDA using the two methods of accepting a language.

26. Define the language recognized by the PDA using empty stack.

27. For the Grammar G defined by the productions
$S \rightarrow A/ B$

$A \rightarrow 0A/\varepsilon$
$B \rightarrow 0B/ 1B/\varepsilon$
Find the parse tree for the yields (i) 1001 (ii) 00101

28. Construct the Grammar with the productions
$E \rightarrow E+E$
$E \rightarrow id$ Check whether the yield id + id + id is having the parse tree with root E or not.
29. What is ambiguous and un ambiguous Grammar?
30. Show that $E \rightarrow E+E/E*E/( E ) / id$ is ambiguous.
31. $S \rightarrow aS/ aSbS/\varepsilon$ is ambiguous and find the un ambiguous grammar.
32. Define the Instantaneous Descriptions ( ID )

## PART-B

1. a) Let G be a CFG and let a=>w in G. Then show that there is a leftmost derivation of w.

b) Let G=(V,T,P,S) be a Context free Grammar then prove that if S=> αthen there is a derivation tree in G with yield α.

2. Let G be a grammar s->OB/1A, A->O/OS/1AA, B->1/1S/OBB. For the string 00110101 find its leftmost derivation and derivation tree.

3) a) If G is the grammar S->Sbs/a, Show that G is ambiguous.

b) Give a detailed description of ambiguity in Context free grammar

4. a) Show that E->E+E/E*E/(E)/id is ambiguous. (6) b)Construct a Context free grammar G which accepts N(M), where M=({q0, q1},{a,b},{z0,z},δ,q0,z0,Φ) and where δis given by

δ(q0,b,z0)={(q0,zz0)}

δ(q0, ε,z0)={(q0, ε)}

δ(q0,b,z)={(q0,zz)}

δ(q0,a,z)={(q1,z)}

δ(q1,b,z)={(q1, ε)}

δ(q1,a,z0)={(q0,z0)}

5. a)If L is Context free language then prove that there exists PDA M such that L=N(M).

b)Explain different types of acceptance of a PDA.Are they equivalent in sense of language acceptance? Justify your answer.

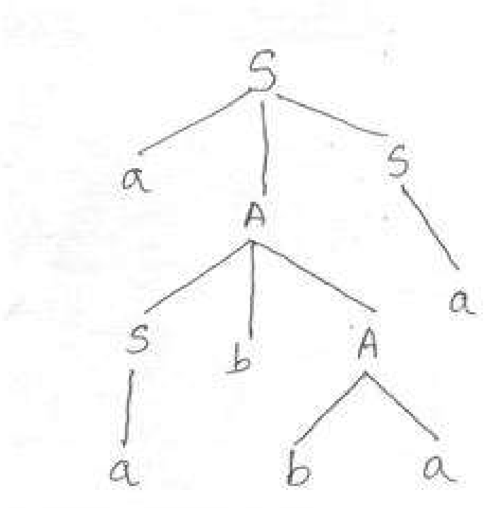
6. Construct a PDA accepting {$a_n b_m a_n$/m,n>=1} by empty stack. Also construct the corresponding context-free grammar accepting the same set.

7. a) Prove that L is L(M2 ) for some PDA M2 if and only if L is N(M1) for some PDA M1.

b)Define deterministic Push Down Automata DPDA. Is it true that DPDA and PDA are equivalent in the sense of language acceptance is concern? Justify Your answer.

8.a) Construct a equivalent grammar G in CNF for the grammar G1 where G1 =({S,A,B},{a,b},{S->bA/aB,A->bAA/aS/a, B->aBB/bS/b},S)

b)Find the left most and right most derivation corresponding to the tree.




9. a) Find the language generated by a grammar

G=({S},{a,b},{S->aSb, S->ab},S) (4)

b) Given G=({S,A},{a,b},P,S) where P={S->AaS|S|SS,A->SbA|ba}
S-Start symbol. Find the left most and right most derivation of the string w=aabbaaa. Also construct the derivation tree for the string w.

c) Define a PDA. Give an Example for a language accepted byPDA by empty stack.

10. G denotes the context-free grammar defined by the following rules. ` S->ASB/ab/SS A->aA/A ,B->bB/A

(i)Give a left most derivation of aaabb in G. Draw the associated parse tree.

(ii)Give a right most derivation of aaabb in G. Draw the associated parse tree.

(iii) Show that G is ambiguous. Explain with steps.

(iv) Construct an unambiguous grammar equivalent to G. Explain.

11 a) Construct the grammar for the following PDA.

M=({q0, q1},{0,1},{X,z0},δ,q0,Z0,Φ) and where δis given by

δ(q0,0,z0)={(q0,XZ0)}, δ(q0,0,X)={(q0,XX)},δ(q0,1,X)={(q1, ε)}, δ(q1,1,X)={(q1, ε)},δ(q1, ε,X)={(q1, ε)}, δ(q1, ε, Z0 )={(q1, ε)}. (12)

b) Prove that if L is N(M1) for some PDA M1 then L is L(M2 ) for some PDA M2.

12.a) Construct a PDA that recognizes the language

$\{a_i b_j c_k \mid i,j,k>0$ and $i=j$ or $i=k\}$.

b) Discuss about PDA acceptance

(1) From empty Stack to final state.

(2) From Final state to Empty Stack.

(i) Explain about Parse trees. For the following grammar (8)

$S \to aB|bA$

$A \to a|aS|bAA$

$B \to b|bS|aBB$

For the string aaabbabbba, Find

(1) Leftmost derivation

(2) Rightmost derivation

(3) Parse tree.

(ii) Construct PDA for the language

$L = \{ww^R \mid W \ in \ (a+b)^*\}$. (8)

13.

14.Explain in detail about equivalence of Push down automata and CFG

(i) Convert the following grammar into GNF.

$S \to XY1/0$

$X \to 00X/Y$

$Y \to 1X1$

(ii) Give formal pushdown automata that accepts $\{wcw^R \mid w \ in \ (0+1)^*\}$ by empty stack. (8)

Or

(i) Show that the following grammars are ambiguous. (6)

$\{S \to aSbS / bSaS / \lambda\}$ and

$\{S \to AB / aaB, A \to a / Aa, B \to b\}$

15. (ii) Prove the equivalence of PDA and CFL. (10)

# UNIT-IV PROPERTIES OF CONTEXTFREE LANGUAGES

## PART-A

1. Define multitape Turing Machine.
2. Explain the Basic Turing Machine model and explain in one move. What are the actions take place in TM?
3. Explain how a Turing Machine can be regarded as a computing device to compute integer functions.
4. Describe the non deterministic Turing Machine model. Is it true the non deterministic
5. Turing Machine model's are more powerful than the basic Turing Machines? (In the sense of language Acceptance).
6. Explain the multi tape Turing Machine mode. Is it more power than the basic turing machine? Justify your answer.
7. Using Pumping lemma Show that the language L={ an bn cn |n>=1} is not a CFL.
8. What is meant by a Turing Machine with two way infinite tape.
9. Define instantaneous description of a Turing Machine.
10. What is the class of language for which the TM has both accepting and rejecting configuration? Can this be called a Context free Language?
11. The binary equivalent of a positive integer is stored in a tape. Write the necessary transition to multiply that integer by 2.
12. What is the role of checking off symbols in a Turing Machine?
13. State Pumping lemma for Context free language.
14. Define a Turing Machine.
15. Mention any two problems which can only be solved by TM.
16. State Pumping lemma and its advantages.
17. What are useless symbols in a grammar.

**PART-B**

1. Find a grammar in Chomsky Normal form equivalent to S->aAD;A->aB/bAB; B->b, D->d.
2. Convert to Greibach Normal Form the grammar G=({A1,A2, A3},{a,b},P,A1 ) where P consists of the following. A1 ->A2 A3, A2 ->A3 A1 /b,A3 ->A1 A2 /a.
3. Construct given CFG into GNF where v={S,A},T={0,1} and P is S → AA/0 , A→SS/1
4. Convert the grammar S->AB, A->BS/b, B->SA/a into Greibach NormalForm.
5. Construct a equivalent grammar G in CNF for the grammar G1 where G1 =({S,A,B},{a,b},{S->bA/aB,A->bAA/aS/a, B->aBB/bS/b}, S)
6. Obtain the Chomsky Normal Form equivalent to the grammars S →aAbB , A →aA/a, B→bB/b
7. Begin with the grammar

S->0A0/1B1/BBA->CB->S/AC->S/ ε and simplify using the safe order Eliminate ε-Productions Eliminate unit production Eliminate useless symbols Put the (resultant) grammar in Chomsky Normal Form

8 Let G=(V,T,P,S) be a CFG. Show that if S=α, then there is a derivation tree in a grammar G with yield α.

9 Let G be the grammar S->aS/aSbS/ ε. Prove that L(G)={x/each prefix of x has 10 atleast as many a's as b's}

11 Explain the Construction of an equivalent grammar in CNF for the grammar G=({S,A,B}{a,b},P,S) where P={S→ a/AAB , A →ab/aB/€ ,B→aba/€.

12 Find a Context free grammar with no useless symbol equivalent to S->AB/CA, B->BC/ABA->a, C->aB/b.

13 Show that any CFL without ε can be generated by an equivalent grammar in Chomsky Normal Form.

14 Convert the following CFG to CNF S->ASA|aB A->B|S B->b| ε

15 Convert into Greibach Normal Form for S→a/AB , A→a/BC ,B→b ,C→b 16 Is L={$a^n$ $b^n$ $c^n$ /n>=1} a context free language? Justify Your answer.

17 Prove that for every context free language L without ε there exists an equivalent grammar in Greibach Normal Form.

18 State and Prove pumping lemma for Context free languages.

19 show that language {ai bj ci dj/i>=1,and j>=1} is not context-free.

20 Design a Turing Machine M to implement the function "multiplication" using the subroutine 'copy'.

21 Explain how a Turing Machine with the multiple tracks of the tape can be used to determine the given number is prime or not.

22 Design a Turing Machine to compute f(m+n)=m+n, V m,n>=0 and simulate their action on the input 0100.

23 Define Turing machine for computing f(m,n)=m-n ( proper subtraction).

24 Explain how the multiple tracks in a Turing Machine can be used for testing given positive integer is a prime or not.

25 Explain in detail:" The Turing Machine as a Computer of integer functions". 26 Design a Turing Machine to accept the language L={$0^n$ $1^n$/n>=1}

27 What is the role of checking off symbols in a Turing Machine?

28 Construct a Turing Machine that recognizes the language {w $_c$w/w € $\{a,b\}^+$ }

29 Prove that the language L is recognized by a Turing Machine with a two way infinite tape if and only if it is recognized by a Turing Machine with a one way infinite tape.

30 Design a TM to recognize each of the following languages. {$ww^R$ | w € $(0+1)^*$}

31 Design a Turing Machine M that decides A={$0^k$ /n>0 and k=2n } the language consisting of all strings of 0's whose length is a power of 2.

32 Demonstrate the working of your TM with an example.

33 Show that the language{$0^n$ $1^n$ $2^n$/n>=1}is not context free.

34 Show that the context free languages are closed under union operation but not under intersection.

35 Design a TM with no more than three states that accepts the language. $a(a+b)^*$.Assume €={a,b}

36. Design a TM to implement the function f(x)= x+1.
37. Design a TM to accept the set of all strings {0,1} with 010 as substring.
38. Design a TM to accept the language LE={$a^n b^n c^n$|n > 1 }

# UNIT-V UNDECIDABILITY

## PART-A

1. When a recursively enumerable language is said to be recursive.
2. Is it true that the language accepted by a non deterministic Turing Machine is different from recursively enumerable language?
3. When we say a problem is decidable? Give an example of undecidable problem?
4. Give two properties of recursively enumerable sets which are undecidable.
5. Is it true that complement of a recursive language is recursive? Justify your answer.
6. When a language is said to be recursive or recursively enumerable?
7. When a language is said to be recursive? Is it true that every regular set is not
8. recursive?
9. When a problem is said to be decidable or undecidable? Give an example of an undecidable.
10. What do you mean by universal Turing Machine?
11. When a problem is said to be undecidable? Give an example of an decidable problem.
12. Show that the union of recursive language is recursive.
13. Show that the union of two recursively enumerable languages is recursively enumerable.
14. What is undecidability problem?
15. Show that the following problem is undecidable."Given two CFG's G1 and G2, is L(G1)∩L(G2)=Φ?".
16. Define recursively enumerable language.
17. Give an example for a non recursively enumerable language.
18. Differentiate between recursive and recursively enumerable languages.
19. Mention any two undecidability properties for recursively enumerable language.
20. Define Diagonal languages.
21. Give an example for an undecidable problem.
22. Define MPCP.

**PART-B**

1. Show that union of recursive languages is recursive.
2. Define the language Ld and show that Ld is not recursively enumerable language.
3. Explain the Halting problem. Is it decidable or undecidable problem
4. Define Universal language Lu.Show that Lu is recursively enumerable but not recursive.

5. Obtain the code for the TM M=({q1,q2,q3},{0,1}, {0,1,B}, δ,q1,B,{q2}) With the moves δ(q1,1)=(q3,0,R) δ(q3,0)=(q1,1,R) δ(q3,1)=(q2,0,R) δ(q3,B)=(q3,1,L) δ(q3,B)=(q3,1,L)
6. Show that $L_n$ is recursively enumerable.
7. Define $L_d$ and show that $L_d$ is not recursively enumerable.
8. Whether the problem of determining given recursively enumerable language is empty or not? Is decidable? Justify your answer.
9. Define the language $L_u$. Check whether $L_u$ is recursively enumerable? or $L_u$ is recursive? Justify your answer.
10. Show that the language $L_d$ is neither recursive nor recursively enumerable.
11. Describe how a Turing Machine can be encoded with 0 and 1 and give an example.
12. Show that any non trivial property J of the recursively enumerable languages is undecidable.
13. Show that if L and L are recursively enumerable then L and L recursive.
14. Define the universal language and show that it is recursively enumerable but not recursive.
15. Prove that the universal language Lu is recursively enumerable.
16. State and Prove Rice's Theorem for recursive index sets.
17. Show that the following language is not decidable. L={<M>| M is a TM that accepts the string aaab}.
18. Discuss the properties of Recursive and Recursive enumerable languages.
19. Define Post correspondence problem with an example.
20. Prove that the function f(n)=2n does not grow at a polynomial rate, in other words, it does not satisfy f(n)=O(np ) for any finite exponent p.
21. Every non trivial property of the RE language is undecidable
22. Show that if a language L and its complement L are both recursively enumerable then L is recursive.
23. What are the features of a Universal Turing Machine?
24. Show that "If a language L and its compliment L are both recursively enumerable,then both languages are recursive".
25. Show that halting problem of Turing Machine is undecidable.
26. Does PCP with two lists x=(b,b ab3,ba) and y=(b3 ,ba , a)have a solution?. Show that the characteristic function of the set of all even numbers is recursive.
27. Let Σ={0,1}.Let A and B be the lists of three strings each,defined as List A List B | $W_i$| = 1, 10111 ,10 |$X_i$ |= 111 ,10 ,0 Find the instance of PCP.
28. Show that it is undecidable for arbitrary CFG's G1 and G2 whether L(G1)∩L(G2)Is a CFL.
29. Show that "finding whether the given CFG is ambiguous or not" is undecidable by reduction technique.
30. Find whether the following languages are recursive or recursively enumerable.
    a. Union of two recursive languages.
    b. Union of two recursively enumerable languages.
    c. L if L and complement of L are recursively enumerable. (iv)Lu (4)
31. Consider the Turing Machine M and w=01, where M=({q1,q2,q3},{0,1}, {0,1,B},δ,q1,B,{q3}) and δis given by Reduce the above problem to Post's correspondence Problem and find whether that PCP has a solution or not.

32. Explain the Post's Correspondence Problem with an example
33. Define $L_{ne}$ and show that $L_{ne}$ is recursively enumerable.
34. Explain in detail NP, NP hard, NP Complete problems giving suitable examples.
35. Convert the TM
M={q1,q2,q3},{0,1},{0,1,,B}, δ,q1,B,{q3}} where δ is given by

| $q_i$ | $\delta(q_i\ 0)$ | $\delta(q_{i,}\ 1)$ | $\delta(q_{i,}\ B)$ |
|---|---|---|---|
| $q_1$ | $(q_2, 1, R)$ | $(q_2, 0, L)$ | $(q_2, 1, L)$ |
| $q_2$ | $(q_3, 0, L)$ | $(q_1, 0, R)$ | $(q_2, 0, R)$ |
| $q_3$ | -- | -- | -- |

and input string w=01.Find the Solution.