**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

**Kattankulathur-603203**

**School of Computing**

**Department of Data Science and Business Systems**

**18CSC301T FORMAL LANGUAGE AND AUTOMATA**

**UNIT-1**

1. According to principle of mathematical induction, if P(k+1) = m(k+1) + 5 is true then \_\_\_\_\_ must be true.

a) P(k) = 3m(k)

b) P(k) = m(k) + 5

c) P(k) = m(k+2) + 5

d) P(k) = m(k)

2.A proof that p → q is true based on the fact that q is true, such proofs are known as

\_\_\_\_\_\_\_\_\_\_\_

a) Direct proof

b) Contrapositive proofs

c) Trivial proof

d) Proof by cases

3.For any positive integer m \_\_\_\_\_\_ is divisible by 4.

a) 5m2 + 2

b) 3m + 1

c) m2 + 3

d) m3 + 3m

4.The “only-if-part” of the statement of “H if and only if S” is \_\_\_\_\_\_\_\_\_\_.

a) if S then H

b) if not S then H.

c) if H then S

d) if not S then not H.

5. The Regular expression101\*10 is generically stated as

**(i) Set of all strings starting and ending with ‘10’ and any number of 1’s in between ‘10’.**

(ii) Set of all strings starting with ‘10’ and ending with ‘10’.

(iii) Set of all strings starting with ‘10’ and ending with ‘10’ and ‘1’ in between them.

(iv) Set of all strings starting with ‘10’ and ending with ‘10’ and ‘10’ in between them.

6. Choose the RE for a language of any combination of 0’s & 1’s containing 1001 as a substring

(i) L=(01)\*1001(01)\*

**(ii)L=(0+1)\*1001(0+1)\***

(iii)L=(01)\*1001(0+1)\*

(iv)L=(0+1)\*1001(01)\*

7. Which pair is equivalent regular expression?

(i) (ab)\* and a\*b\* (ii) a(aa)\* and (aa)\*a (iii) a+ and a\*a

a. Only (i)

b. Only (ii)

**c. (ii) and (iii)**

d. (i)(ii) and (iii)

8. NFA’s accept

1. **Regular Languages**
2. More languages than a DFA can accept
3. Languages that are not regular
4. Context Free Languages

9. Which one of the following languages over the alphabet {0, 1} is described by the regular expression (0 + 1) \*0(0 + 1) \*0(0 + 1) \*?

(a) The set of all strings containing the substring 00

(b) The set of all strings containing at most two 0’s

**(c) The set of all strings containing at least two 0’s**

(d) The set of all strings starting and ending with 0 or 1

10. What is the minimum number of states to recognise the language L={w/w ϵ (0+1+2)+}?

1. 1 b) 2 c) 3 d) 4
2. What is the minimum number of states required by the DFA that accepts the language? L={a | a is a number divisible by n} ?
3. n b) n+1 c) n-1 d) 2n
4. \_\_\_\_\_\_\_ is the maximum number of states that an ε-NFA can have on ε moves.

a) n

b) 0

c) Infinite

d) 1

13. The FSA to recognize the words “infrared” and “infrastructure” has \_\_\_\_\_ number of states.

a) 20

b) 22

c) 15

d) 17

14. NFA with ϵ transitions \_\_\_\_\_\_\_

a) Increases computations

b) Decreases computations

c) Decreases number of states

d) Increases uncertainty

15. What are the maximum number of output states for any input state (n) in a NFA?

a) n

b) n+1

c) 2n

d) n-1

16. I: DFA’s can be constructed for all the languages

II: The strings accepted by DFA will be accepted by NFA

What can be said about these two statements?

a) Only II is false

b) Only I is false

c) I is false and II is true

d) II is true and I is false

17. What can be told about the recognising capability of NFA, ε-NFA and DFA?

a) All three are equally powerful

b) ε-NFA is more powerful and flexible

c) ε-NFA is less powerful and flexible

d) DFA is more powerful

18. What is the minimum number of states for NFA that accepts the language {01n 01 | n >=0}?

a) 5

b) 4

c) 6

d) 16

19. Which of the given languages are accepted by Non Deterministic PDA but not by Deterministic PDA?

a) Language generating strings that contain at least one symbol repeated at least twice

b) Even Palindromes

c) Strings ending with a particular symbol

d) Strings starting with particular symbol

20. Regular expression for all strings starts with ab and ends with bba is.  
a) aba\*b\*bba  
b) ab(ab)\*bba  
c) ab(a+b)\*bba  
d) All of the mentioned

21. Under which of the following operation, NFA is not closed?  
a) Negation  
b) Kleene  
c) Concatenation  
d) None of the mentioned

22. Ragu is asked to make an automaton which accepts a given string for all the occurrence of ‘1001’ in it. How many number of transitions would John use such that, the string processing application works?  
a) 9  
b) 11  
c) 12  
d) 15

**23.** Which of the following does not represents the given language? Language: {0,01}  
a) 0+01  
b) {0} U {01}  
c) {0} U {0}{1}  
d) {0} ^ {01}

**24.** Which among the following looks similar to the given expression?  
((0+1). (0+1)) \*  
a) {xϵ {0,1} \*|x is all binary number with even length}  
b) {xϵ {0,1} |x is all binary number with even length}  
c) {xϵ {0,1} \*|x is all binary number with odd length}  
d) {xϵ {0,1} |x is all binary number with odd length}

**25.** RR\* can be expressed in which of the forms:  
a) R+  
b) R-  
c) R+ U R-  
d) R

**26.** Which of the following represents a language which has no pair of consecutive 1’s if ∑= {0,1}?  
a) (0+10)\*(1+ε)  
b) (0+10)\*(1+ε)\*  
c) (0+101)\*(0+ε)  
d) (1+010)\*(1+ε)

**27.** Let the class of language accepted by finite state machine be L1 and the class of languages represented by regular expressions be L2 then  
a) L1<L2  
b) L1>=L2  
c) L1 U L2 = .\*  
d) L1=L2

28. Let N (Q, ∑, δ, q0, A) be the NFA recognizing a language L. Then for a DFA (Q’, ∑, δ’, q0’, A’), which among the following is true?  
a) Q’ = P(Q)  
b) Δ’ = δ’ (R, a) = {q ϵ Q | q ϵ δ (r, a), for some r ϵ R}  
c) Q’ = {q0}  
d) All of the mentioned

29. If L1 and L2′ are regular languages, L1 ∩ (L2′ U L1′)’ will be  
a) regular  
b) non regular  
c) may be regular  
d) none of the mentioned

DESCRIPTIVE QUESTIONS

1. Show that 22n-1 is divisible by 3 using the principles of mathematical induction.
2. Prove that if for an integer a, a2 is divisible by 3, then a is divisible by 3 using the proof by contradiction.
3. For any two integers a and b, (a+b) is odd if and only if exactly one of the integers a or b is odd. Prove the above statement.
4. Show by counter example the given statement P is not always true.

P = 2n2-16n+31 is always positive for all of n.

1. Prove using mathematical induction for n>=5, 2n>n2.
2. Prove that the sum of n squares can be found as follows

12+22+32+...+n2=n(n+1)(2n+1)/6

1. Describe the Language generated by the following Regular Expression (0)\*(101)\*11.
2. . **Identify the Regular Expression for the following:**

A language consists of any combination of 0’s & 1’s, beginning and ending with the string ‘01’.

1. Justify whether Regular expression exist for the following scenario.

Seetha wants to write the Regular expression for the set of all strings which contain repeated substrings of any length>1[E.g., “aba” Substring ‘a’ Repeats].

10.Recognize the term Epsilon (ε) – closure. Identify the Epsilon (ε) closure of the state qo in the following NFA.

A drawing of a diagram

Description automatically generated

11.Memorize the 5 tuple structure of DFA and NFA.

12. Construct a DFA that can recognise the six-symbol password over the input Σ={a, b, c} with the following conditions:

1. Password should start with ‘ab’
2. Password should not end with ‘bb’.
3. Construct a DFA that accepts the numbers that are multiples of five in its binary form.
4. Construct a DFA and NFA that accepts strings that starts with ‘abb’ and ends with any number of ‘a’.
5. Ramesh has to create an FSA that accepts string over {a, b, c} in such a way that the fourth symbol from the right is always ‘c’. Can he construct both NFA and DFA? Justify your answer.
6. Is it possible to create an NFA and ε-NFA over {0,1} that accepts L={0n 1m 2o| n, m, o >=0}? If so, give the construct.
7. Is it possible to create an NFA and ε-NFA over {0,1} that accepts L={0n 1m 2o| n, m, o >0}? If so, give the construct.
8. Design a NFA that recognises the strings ‘abc’, ‘abd’, ‘aacd’ over the input Σ={a, b, c, d}.
9. Convert the following NFA to DFA:

|  |  |  |
| --- | --- | --- |
| δ | 0 | 1 |
| ->Q0 | {Q1, Q2} | {Q0} |
| Q1 | {Q1, Q2} | Φ |
| \*Q2 | Q1 | {Q1, Q2} |

1. Describe a Regular Expression. Write a Regular Expression for the set of strings that consists of alternating 0’s and 1’s.
2. Examine whether the language L=(0 n 1 n | n>=1) is regular or not? Justify your answer.
3. Construct Finite Automata equivalent to the regular expression (ab+a)\*
4. Construct NDFA for given RE using Thomson rule.
5. a(a+b)\* ab
6. (a.b)\*
7. (a+b)
8. Find the Regular Expression equivalent for the given Finite Automata.

A diagram of a circle with arrows and a circle with a point

Description automatically generated

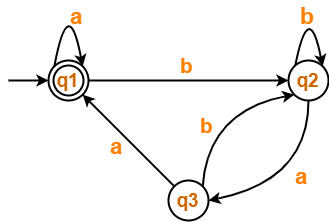
1. Evaluate the equalities for the following RE and prove for the same

(i) b+ab\* +aa\*b+aa\*ab\*

(ii) a\*(b+ab\*).

(iii) a(a+b)\*+aa(a+b)\*+aaa(a+b)\*

1. Find the Regular Expression equivalent for the given Finite Automata.



1. Construct a DFA which is equivalent to the following regular expression:

00 ∪ (1 ∪ 01)(11 ∪ 0)∗10 ∗

|  |  |
| --- | --- |
|  | **UNIT-II** |
| **Q.No** | **Questions** |
|  | A black and white image of words  Description automatically generatedS -> NP VP  NP -> Det N | ‘Arjun’  VP -> V NP | VP PP  PP -> P NP  Det -> 'a' |‘the’  N -> 'tiger' | 'forest'  V -> 'hunts'  P -> 'in’   1. Elimination of Left recursion (1 mark) 2. Remove the null production  (1 mark)   c) Remove the unit production (1 mark)  d) Convert to CNF (2 marks)  e) Convert to GNF (3 marks)  f)  Convert to PDA (5 marks)  g) Acceptance of PDA by Final State / Empty Stack (2 marks) |
|  | Consider following grammar  declarationlist → declaration | declarationlist declaration  declaration → type idlist T  idlist → idlist ’,’ I | I  type →int | float | char  T → ;  I → ID  (a) Identification of terminal and non-terminal ( 3 marks)  (b) Simplification of Grammar (5 marks)  (c) Conversion of GNF (6 marks)  (d) PDA creation (6 marks)  (e) String acceptance and Rejection (5 marks) |
|  | A telephone operator was asked to prioritize the calls based on the roles the people hold in the organization. The calls will be made by the personnel among the departments. The following are the Context Free Grammars that would assist the telephone operator in prioritizing the calls:  Executive\_Committee🡪Risk Committee **manager** Security\_Committee  Security\_Committee🡪Security Committee **chief\_ operating\_ officer** Local\_Security\_Committees  Security\_Committee🡪 Security\_Committee **chief\_ operating\_ officer** Information\_Security| Security\_Committee🡪 Information\_Security  Information\_Security🡪**zonal\_officers| nodal\_officers | regional\_officers**  Local\_Security\_Committees🡪Information\_Asset\_Owners **marketing\_officer** Site\_Security  Risk Committee🡪**guards**  Site\_Security🡪**guards**  Information\_Asset\_Owners🡪**information\_manager**  Local\_Security\_Committees🡪**monitoring\_guard**  [ terminals are in bold]  Convert the grammar to GNF |
|  | Consider the following grammar  S1->S1 FW S2|S2  S2->S2 PW S3|S3  S3->**cat|dog**  FW-> **Fought with**  PW->**Played with**  [Hint: terminals are indicated in bold]   1. Can the string “ Cat Fought With dog“ be derived unambiguously. 2. Optimize the grammar – 3 marks 3. Convert the given grammar to Chomsky Normal Form (CNF) – 5 marks 4. Convert the given grammar to Greibach Normal Form (GNF) – 7 marks 5. Write Leftmost Derivation, Rightmost Derivation and Parse Tree for the string “the boy went to the school” – 3 marks 6. Convert the given grammar to Pushdown Automata – 7 marks |
|  | Engineering is all about Engineering added with Technology or only knowing Technology. Likewise, to know about Technology, one should be strong in both Technology and Fundamentals or at least Fundamentals. Finally, that Fundamentals what we learn gives the best outcome as knowledge. From the above scenario, construct the Grammar and write down the productions.  Check whether input string id+id\*id can be derived unambiguously. Also optimize the grammar. |
|  | An equity trader invested in two stocks with different quantities where the quantity is represented as x and y respectively, and the unit price of the stocks was a and b respectively. He then realized that during market crash, whenever he invested in a third stock with the same quantity as that of his first stock, he could make a reasonable profit and so he invested in a third stock of quantity x. So, the stocks that would achieve profits would be represented as axbycx where c is the unit price of the third stock.   1. Construct a  grammar to generate all such strings. (3 marks) 2. Reason out if the language can be generated by a regular grammar or not (no need to write detailed proof). (3 marks) 3. Design a suitable automaton to accept all such strings. (5 marks) 4. Show the sequence of leftmost derivations for the string  a2b1c2 using your grammar. (3) 5. Show the sequence of instantaneous descriptions (IDs) leading to an accepting state for the string a2b1c2 using the automaton. (3 marks)   What change should be made to the language so that the language cannot be generated using a CFG? Justify using pumping lemma that your language cannot be accepted by any CFG |
|  | Seetha is applying for driving license. She checks for the eligibility in RTO office. It says the first mandatory eligibility is age. The age (A) must be from 18 to 59. The optional eligibility is educational qualification (Q). It can be undergraduate (ug), postgraduate (pg), diploma (dip). Define context free grammar (CFG) for the given scenario. Check whether the person who holds a post graduate degree but 61 years is eligible to get the diving license. Also normalize the grammar suited to form binary tree. |
|  | Ram wants to design a machine which takes input address in the form of text segment. This text segment may in turn be in the form of a text paragraph and text segment separated by comma or just a text paragraph. The text paragraph will be list of words or single phrase. The single phrase can be a number or name (which are terminals). Whereas the list of words will again lead to text segment confined within (). Design a CFG for the above scenario. And find out whether the Rams address “124 NRRstreet” can be derived from a CFG constructed for this scenario? Also convert the grammar to CNF. |
|  | Infer and analyze the following productions and frame a well defined Grammar. Sandy has two boxes. First Box contains a small gum, a Big Pencil and a small Eraser. The second box contains small eraser, Big Ruler and a small sharpener. Big Pencil contains a small eraser at the back of it. The Big Ruler contains a small key chain attached to it. Write suitable CFG and convert to GNF. |
|  | Archeological department of Tamilnadu Government has taken an initiative to identify the actual date of the discovered antique pieces. The department is maintaining a statistical database mandatorily entering the historical date Design CFG for analysing date in proper format and storing. The mandatory condition for the CFG de  sign is as follows. The date format should be Date-Month-Year (dd-mm-yyyy). In addition, parse the given input strings.  a. 24-08-1752  b. 01-12-0679 |
|  | **UNIT-III** |
| 1. | Consider following push down automata (Hint: i = if, t = then, g = goto)  δ(q1,ε,Z) →( q1 , SZ)  δ(q1,20,N) →( q1 , ε)  δ(q1,),Y) →( q1 , ε)  δ(q1,>,X) →( q1 , ε)  δ(q1,10,W) →( q1 , ε)  δ(q1,a,V) →( q1 , ε)  δ(q1,t,T) →( q1 , ε)  δ(q1,g,G) →( q1 , ε)  δ(q1,i,S) →( q1 , DTGN)  δ(q1,(,D) →( q1 , VXWY)  (a) Convert the given PDA to CFG (10)  (b) Simplify the grammar (2)  (c) Convert to GNF form (5)  (d) write the formal definition for both given PDA and Converted grammar (4)  (e) Identify the string w=if (a<10) then goto 20 and write the ID for string acceptance (4) |
| 2. | A company named “FLA Designs and Solutions” launched a portal for the benefits of their employees. In this context, the employees need to be registered newly in the portal. For password generation the guidelines given as follows.   1. The password is combination of alphabets, digits and special characters. 2. The password should start with an alphabet and end with digit 3. The number of alphabets should be equal to number of digits and number of special characters greater than the number of alphabets. 4. All the symbols should occur consecutively.   Also validate the automata for an example string. |
|  | Consider the following set of grammars. These grammars generate infinite language of strings. Find the following:  The Symbol S is the starting symbol  S→wvS| wv  S→wV |wv ;V→vS  S→SS | wv  S→wV |w ;V→vS  S→wV ;V→vS|w  S→wV | v ;V→vS  S→wV ;V→vS |v  S→wV ;V→vS | wv  Identify the language generated by these grammars and find the pattern of language used in majority of grammars (4)  The pairs of grammar that generate same language(6)  Convert the one of the grammar found in previous question to CNF (5)  Convert the Grammar to GNF (10 mark) |
|  | A PDA is defined as M={ Q,Σ,Γ,δ,q\_(0,) Z\_(0,) F} and its definition is as following:  Q={ a ,b} ,  Σ={x,y},  Γ={ Z\_0,S},  δ is given as follows∶  1.δ (a,ϵ,ϵ)=(a,Z\_0 )  2.δ(a,x,Z\_0 )=(a,SZ\_0 )  3.δ (a,x,S)=(a,SS)  4.δ(a,y,S)=(a,S)  5.δ(a,ϵ ,S)=(b,ϵ)  6.δ(b,ϵ,S)=(b,ϵ)  7.δ(b,y,S)=(p,SS)  8.δ(b,y,Z\_0 )=(b,ϵ)  Describe the working of the PDA (4)  Show the ID moves for the input xyyxxyyxy (3)  Find out the any of the possible input at when the PDA enter state b for the first time with all inputs consumed and the stack has the contents as SSZ\_0 i.e., what is (b,ϵ,SSZ\_0 )⊢ ? (10)  Convert the above PDA to CFG (8) |
|  | A company organized an annual celebration event for all its employees. The employees participated in various games of the events. One such game is picking the ball from the pool. The employee has to pick the balls in the order specified. The one who is picking all the balls in the specified order at the earliest is the winner. The colored balls are Red, Green, Violet, Yellow.  **Case (i):**  First, they should pick ‘n’ number of red balls then ‘m’ number of green balls then ‘n’ number of Violet balls and at last ‘p’ number of yellow balls.  **Case (ii):**  Or else, first they should pick ‘n’ number of red balls then ‘m’ number of green balls then ‘2n’ number of Violet balls and at last ‘p’ number of yellow balls.  The order should not vary. Design a single Push Down Automata to check the order and constraints of the game satisfying both the cases. Explain the designed PDA with example strings.  **Evaluation Scheme for student reference**  1. Identification of Non-deterministic Pushdown Automata – 2 marks  2. Writing Language and giving example strings for the given scenario – 4 marks  3. Construction of Non-deterministic PDA for the given statement – 8 marks  4. Formal Definition of Constructed PDA – 5 marks  4.  Example for First case – 3 marks  5.  Example for Second case – 3 marks |
|  | Read the Following Scenario and answer the following questions  Consider there are two color cubes (Blue and Green) they are equal in number. The logic is Blue cube to be taken and stack all the blue cubes first. Later once no more blue cubes available for each green cubes remove one blue cubes from the stack. Make sure stack should be clear.  a. Generate the accepting language for above Scenario – 3 Marks  b. List the PDA and CFG Tuple representation for above scenario – 4 Marks  c. Frame the 3 rules for give scenario for PDA to CFG conversion – 3 marks  d. Design PDA transitions for the given scenario – 3 marks  e. Illustrate using a PDA Diagram for the above scenario – 2 marks  f. Using elimination rules for each transitions generate Context Free Grammer from given PDA – 8 marks  g. List the final productions - 2 Marks |
|  | Consider the HTML table tags we have <tr> for table row and <td> for cell definition. For each row <tr>we have cell tag definition <td> cell content here</td>. Construct a push down automata to check the balancing of <td> and </td> tags and <tr> </tr> tags. Order need to be considered has to follow i.e.,  <tr>  <td>cell definition</td>  <td>cell definition</td>  </tr>  The automata for just check the balance in count of table row tags and cell definition tags . Assume, for the strings in the language, that all the cell contents are removed and only tags are present.  i) Write the language with simple string accepted by the automata. (3)  ii) Construct a Grammar for the above scenario ( 8)  iii) Convert the grammar to GNF ( 9)  iv) Construct the PDA diagram, along with transition function (5) |
|  | The esteem institute conducts the placement for all the final year students. The students participated in various rounds of the placements. One such round is choosing the pattern of the written exam. The student has to choose the questions in the order specified. The one who is choosing all the questions in the specified order of answering at the earliest is the winner. The questions are MCQ, FILL IN THE BLANKS, MATCH THE FOLLOWING, DESCRIPTIVE.  Case (i)  First, they should choose and answer ‘n’ number of MCQ then ‘m’ number of FILL IN THE BLANKS then ‘n’ number of MATCH THE FOLLOWING and at last ‘p’ number of DESCRIPTIVE.  Case (ii)  Or else First, they should choose and answer ‘n’ number of MCQ then ‘m’ number of FILL IN THE BLANKS then ‘2n’ number of MATCH THE FOLLOWING and at last ‘p’ number of DESCRIPTIVE.  The order should not be changed. Design the suitable pushdown automata to check the order and satisfies the above cases. Illustrate with an example pattern.  **Evaluation Scheme for student reference**  1. Identification of Non-deterministic Pushdown Automata – 2 marks  2. Writing Language and giving example strings for the given scenario – 4 marks  3. Construction of Non-deterministic PDA for the given statement – 8 marks  4. Formal Definition of Constructed PDA – 5 marks  4.  Example for First case – 3 marks  5.  Example for Second case – 3 marks |
|  | Let Σ = {a, b, c, +, ×,(,)}. Design a PDA whose language is {w | w is a valid algebraic expression}.The Open bracket should be always end with close bracket. L is the language in which given alphabets abc. Apply the logic, represent the necessary transition function and diagram with tuple representation. |

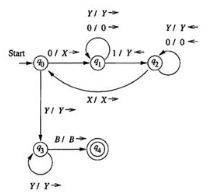
**UNIT-IV**

1. Considering the tape symbol as a tuple - Multiple tracks Turing Machine
2. Can a multi-track Turing machine can be converted to single track Turing machine (**TRUE** /FALSE)?
3. Are Multi-tape and multi-track Turing machine same? (**TRUE** /FALSE)
4. The value of m if Turing machine is defined using m-tuple
5. 6
6. **7**
7. 8
8. 5
9. In multi tape Turing machine, the head of the first tape is at the end of the input
10. **Left**
11. Right
12. Middle
13. Corner
14. S1: There exists a deterministic Turing machine corresponding to each non-deterministic Turing Machine

S2: There exists a single tape Turing machine corresponding to each multi-tape Turing machine.

Which of the following is correct?

1. **Both S1 and S2 are true**
2. Neither S1 and S2 are true
3. Only S1 is true
4. Only S2 is true
5. The below transition diagram accept the \_\_\_\_\_\_\_string



1. 0n1n
2. 0n0n1n
3. 0n0n
4. 1n1n
5. An equity trader invested in two stocks with same quantities where the quantity is represented as n. He then realized that during market crash, whenever he invested in a third stock with the same quantity as that of his first stock, he could make a reasonable profit and so he invested in a third stock of quantity n. Help the investor with a diagrammatic representation of suitable turing machine that would accept only if the investments would yield a reasonable profit by satisfying the above mentioned criteria.

Sol: Turing Machine for L ={ anbncn}

1. Describe the following Turing machine and their working. Are they more powerful than the Basic Turing Machine?

• Multi-tape (Multiple Track) Turing Machine

• Multi-Dimensional Turing Machine

• Two-Way infinite tape TM

1. Construct a TM to accept {0n1n / n>=1} using Multi track TM concept

Sol: We explicitly think of the tape as if it was composed of tracks.

A table of mathematical equations

Description automatically generated

1. The difference between a read-only Turing machine and a two-way finite state machine is
2. Head Movement
3. Finite Control
4. Storage Capacity
5. Power
6. Which of the following is true for two stack Turing machines?  
   a) one read only input  
   b) two storage tapes  
   c) one read only input & two storage tapes  
   d) two read only input & two storage tapes
7. If instead of moving left or right on seeing an input, the head could also stay at one position without moving anywhere is called as \_\_\_\_\_\_\_\_
8. **Turing Machine with Fixed Tape**
9. **Turing Machine with Stay option**
10. **Turing Machine with Semi-infinite tape**
11. **Offline Turing machine**
12. In standard Turing machine the input symbol can be changed to blank, but if we remove this facility of changing the input symbol to blank then such type of Turing machine is called as \_\_\_\_\_\_\_\_\_\_\_\_\_
13. Non erasing Turing Machine
14. Jumping Turing Machine
15. Always writing Turing Machine
16. Offline Turing machine
17. A\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is one whose tape alphabet consists of exactly two symbols.
18. Alphabet based Turing Machine
19. Binary Turing Machine
20. Count based Turing Machine
21. Symbols based Turing Machine
22. Whether it is possible to increase the number of languages accepted by performing some modifications in Standard Turing Machine? If Yes, Justify the ways of modifications.
23. A Turing machine with doubly infinite tape is similar to an ordinary Turing machine, but its tape is infinite to the left as well as to the right. The tape is initially filled with blanks except for the portion that contains the input. Computation is defined as usual except that the head never encounters an end to the tape as it moves leftward. Show that this type of Turing machine recognizes the class of Turing-recognizable languages.
24. Design a Multi tape Turing Machine for L= anbncn
25. **Use the pumping lemma to prove that the language is not context free.**
26. Show that Kruskal’s algorithm is in class P.
27. Show that the satisfiability problem is in class NP.
28. **Construct a Turing machine that accepts all input in the following format: number of A’s (at least 1) followed by number of B’s (at least 1). Draw the transition diagram; write the instantaneous description and the transition function. Also give the tuple Notation for the designed TM.**
29. **Construct a Turing machine to perform function f(x) = x2**
30. **.Design a Turing Machine to compute 1's complement**
31. **Smriti brought 8 boxes of sweets. Each box contains 2 sweets. How many sweets would be left with her after giving 10 sweets to friends? Help smriti by designing a Turing machine to find the remaining amount of sweets**
32. **Show that the following post correspondence problem has a solution and if so give the solution.**

|  |  |  |
| --- | --- | --- |
| **i** | **List A**  **Wi** | **List B**  **Xi** |
| **1** | **11** | **111** |
| **2** | **100** | **001** |
| **3** | **111** | **11** |

1. Do phrase structure analysis of the following sentences

The dog saw a man in the park