SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

18CSC301T FORMAL LANGUAGE AND AUTOMATA

Question Bank

UNIT IV

PART A

1. **List the component of Turning machine (DEC 15)** A
   Turing machine has two main components:

   - A finite state machine that acts as a controller
   - A two way infinite tape divided into cells, from which the machine can read input symbols, moves left or right, and onto which the machine can write output symbols

2. **State the advantage of Turning machine over automata (June 16)**
   - The simplest automata used for computation is a finite automaton. It can compute only very primitive functions; therefore, it is not an adequate computation model.
   - The Turing machine can be thought of as a finite automaton or control unit equipped with an infinite storage (memory).

3. **Differentiate FA and TM (June 16)**

Finite Automata	Turning Machine
FA is denoted by 5 tuple $(Q, \Sigma, \delta, q_0, F)$	A Turing machine is denoted by 7 tuple $M=(Q, \Sigma, \Gamma, \delta, q0, B, F)$
It has no memory unit	A TM has infinite storage capacity
It can recognize context free language	It can compute integral functions

4. **Define Turing machine. (DEC 15, June 16)**

   A Turing machine is denoted as $M=(Q, \Sigma, \Gamma, \delta, q0, B, F)$

   Q is a finite set of states.

   Σ is set of i/p symbols ,not including B. Γ is the finite set of tape symbols.

   q0 in Q is called start state.

   B in Γ is blank symbol.

   F is the set of final states.

   δ is a mapping from $Q \times \Gamma$ to $Q \times \Gamma \times \{L,R\}$.

5. **Define Instantaneous description of TM.**

   The ID of a TM M is denoted as $\alpha1\ q\ \alpha2$. Here q is the current state of M is in Q; $\alpha1\ \alpha2$ is the string in Γ^* that is the contents of the tape up to the rightmost nonblank symbol or the symbol to the left of the head, whichever is the rightmost.

6. **What are the applications of TM?** TM

can be used as:

- Recognizers of languages.
- Computers of functions on non negative integers.
- Generating devices.

7. **What is the basic difference between 2-way FA and TM?**

Turing machine can change symbols on its tape , whereas the FA cannot change symbols on tape. Also TM has a tape head that moves both left and right side ,whereas the FA doesn't have such a tape head.

8. **Define a move in TM.**

Let $X_1 X_2 \ldots X_{i-1}\, q\, X_i \ldots X_n$ be an ID.

The left move is: if $\delta(q, X_i) = (p, Y, L)$,if i>1 then

$X_1 X_2 \ldots X_{i-1}\, q\, X_i \ldots X_n$ |---- $X_1 X_2 \ldots X_{i-2}\, p\, X_{i-1}\, Y\, X_{i+1} \ldots X_n$.

The right move is if $\delta(q, X_i) = (p, Y, R)$,if i>1 then

$X_1 X_2 \ldots X_{i-1}\, q\, X_i \ldots X_n$ |---- $X_1 X_2 \ldots X_{i-1} Y\, p\, X_{i+1} \ldots X_n$.

9. **What is the language accepted by TM?**

The language accepted by M is L(M) , is the set of words in Σ^* that cause M to enter a final state when placed ,justified at the left on the tape of M, with M at q_0 and the tape head of M at the leftmost cell. The language accepted by M is:

{ w | w in Σ^* and $q_0 w$ |-- $\alpha_1\, p\, \alpha_2$ for some p in F and α_1, α_2 in Γ^* }.

10. What are the various representation of TM?

We can describe TM using:

- Instantaneous description.
- Transition table.
- Transition diagram.

11. What are the possibilities of a TM when processing an input string?

- TM can accept the string by entering accepting state.
- It can reject the string by entering non-accepting state.
- It can enter an infinite loop so that it never halts.

12. What are the techniques for Turing machine construction?

- Storage in finite control.
- Multiple tracks.
    - Checking off symbols.
    - Shifting over
    - Subroutines.

13. What is the storage in FC?

The finite control(FC) stores a limited amount of information. The state of the Finite control represents the state and the second element represent a symbol scanned.

14. When is checking off symbols used in TM?

Checking off symbols is useful method when a TM recognizes a language with repeated strings and also to compare the length of substrings.

(eg) : { ww | w Є Σ * } or {aibi | i>=1}.

This is implemented by using an extra track on the tape with symbols Blank or √.

15. What is a multihead TM?

A k-head TM has some k heads. The heads are numbered 1 through k, and move of the TM depends on the state and on the symbol scanned by each head. In one move, the heads may each move independently left or right or remain stationary.

16. What is a 2-way infinite tape TM?

In 2-way infinite tape TM, the tape is infinite in both directions. The leftmost square is not distinguished. Any computation that can be done by 2-way infinite tape can also be done by standard TM.

17. Differentiate PDA and TM.

PDA	TM
1. PDA uses a stack for storage.	1. TM uses a tape that is infinite .
2.The language accepted by PDA is CFL.	2. Tm recognizes recursively enumerable languages.

18. What is a multi-tape Turing machine? (DEC 15)

A multi-tape Turing machine consists of a finite control with k-tape heads and k-tapes ; each tape is infinite in both directions. On a single move depending on the state of finite control and symbol scanned by each of tape heads ,the machine can change state print a new symbol on each cells scanned by tape head, move each of its tape head independently one cell to the left or right or remain stationary.

19. What is a multidimensional TM?

The device has a finite control, but the tape consists of a k-dimensional array of cells infinite in all 2k directions, for some fixed k. Depending on the state and symbol scanned, the device changes state, prints a new symbol and moves its tape-head in one of the 2k directions, either positively or negatively, along one of the k-axes.

20. State the halting problem of TMs.

The halting problem for TMs is: Given any TM M and an input string w, does M halt on w. This problem is undecidable as there is no algorithm to solve this problem.

PART B

1. Construct a TM to accept palindrome in an alphabet set $\sum = \{a,b\}$. Trace the string "baab" and "abab" (8 mark May 16)
2. Design a Turing Machine to reorganization the language L= $\{a^n cb^n | n \geq 0\}$ (12 mark May 16)
3. Explain the programming technique for TM (10 mark Dec 15)
4. Design a Turing Machine to reorganization the language L= $\{0^n 1^n | n \geq 1\}$ also specify the ID to trace the string 0011(10 mark Dec 15,June 14)
5. Describe how TM is useful for computing arithmetic functions. How can we perform proper subtraction? (8)

6. Design a Turing Machine M to implement the function "multiplication" using the subroutine 'copy'. (12 mark Dec 14)

7. Explain the variations of TM (16 mark May 16, Dec13)

   (or)

   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

8. Explain halting problem. Is it solvable or unsolvable problem discuss. (8 mark May 16)

   (or)

   State and describe halting problem. For TM (6 mark Dec 15)

9. Describe Chomsky hierarchy of language with example. What are the devices that accept these language. (8 mark May 16, Dec 15)

10. What is the role of checking off symbols in a Turing Machine? (6 Mark June 14)