

Q.P. Code: 22218

(2 ½ Hours)

[Total Marks: 75]

- N.B.** 1) All questions are **compulsory**.  
 2) **Figures** to the **right** indicate marks.  
 3) **Draw** suitable **diagrams** and illustrations **wherever necessary**.  
 4) **Mixing** of sub-questions is **not allowed**.

### Q. 1 Attempt All the Questions

#### A. Choose the correct alternative

(5M)

- i. A transition graph is a finite directed labelled graph in which each \_\_\_\_\_ represents a state and \_\_\_\_\_ indicate the transition of a state and the edges are labelled with input/output.
  - a) undirected edge, vertex
  - b) vertex, undirected edge
  - c) directed edge, vertex
  - d) vertex, directed edge
- ii. The set  $\{\Lambda, 0, 00, 000, \dots\}$  can also be represented by \_\_\_\_\_.
  - a)  $0^*$
  - b)  $0^+$
  - c)  $\Lambda + 0$
  - d)  $0^* + 0^+$
- iii. A derivation tree is also called \_\_\_\_\_.
  - a) null tree
  - b) binary tree
  - c) acyclic graph
  - d) parse tree
- iv. A \_\_\_\_\_ has a read-only input tape, an input alphabet, a finite state control, set of final states, an initial state and a stack called pushdown store.
  - a) Moore machine
  - b) pushdown automata
  - c) Mealy machine
  - d) DFA
- v. The acceptability of a string is decided by the reachability from the \_\_\_\_\_ state to some \_\_\_\_\_ state.
  - a) initial, current
  - b) current, final
  - c) initial, final
  - d) next, final

#### B. Fill in the blanks (Choose correct one from the pool)

(5M)

{one, zero, Turing machine, Arden's theorem, Pumping Lemma, nondeterministic, derivation, deterministic}

- i. Empty string ( $\Lambda$ ) has length \_\_\_\_\_.
- ii. \_\_\_\_\_ provides an ideal theoretical model of a computer.
- iii. \_\_\_\_\_ is used to show that certain sets are not regular.
- iv. \_\_\_\_\_ involves application of productions.
- v. When the moves of the machine cannot be determined uniquely by the input symbol and the present state, such an automaton is called \_\_\_\_\_ automaton.

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**C. Explain the following terms in one or two lines (5M)**

- Define language.
- What is the regular expression corresponding to the set of all the strings over  $\{a, b\}$  containing exactly  $2a$ 's.
- Compare between Moore and Mealy Machines.
- What is a sentence?
- When do we say two regular expressions are equivalent?

**Q.2 Attempt the following: (Any THREE) (15M)**

- Define an automaton. Explain its various components.
- Construct a Mealy Machine which is equivalent to the Moore machine given by the following table.

Present state	Next State $\delta$		Output
	a=0	a=1	
$\rightarrow q_0$	$q_3$	$q_1$	0
$q_1$	$q_1$	$q_2$	1
$q_2$	$q_2$	$q_3$	0
$q_3$	$q_3$	$q_0$	0

- Construct a DFA accepting all the string  $w$  over  $\{0, 1\}$  such that the number of 1's in  $w$  is  $3 \pmod{4}$ .
- Construct a grammar  $G$  accepting the set  $L$  of all strings over  $\{a, b\}$  having more  $a$ 's than  $b$ 's.
- Construct a finite automaton equivalent to  $(0+1)^*(00+11)(0+1)^*$
- State and prove Pumping Lemma for regular sets.

**Q.3 Attempt the following: (Any THREE) (15M)**

- Define pushdown automata. Explain its design.
- What is context free grammar? Construct a context free grammar  $G$  generating all integers.
- Define ambiguous grammar. Find if the following set of production of a grammar make it ambiguous?

P:  $S \rightarrow \text{if } b \text{ then } U$   
 $S \rightarrow \text{if } b \text{ then } U \text{ else } S$   
 $S \rightarrow a$   
 $U \rightarrow \text{for } c \text{ do } S$   
 $U \rightarrow a$

- Show that  $L = \{ a_p / p \text{ is a prime} \}$  is not regular.
- Define Regular grammar. Also Generate the transition diagram for the following regular expressions.
  - $a^*b(a+b)^*$
  - $a^*+b$



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F. What is derivation tree? Give example to explain the concept.

**Q.4 Attempt the following: (Any THREE)**

(15M)

- A. What is Turing machine? Explain its composition and its operation.  
 B. Describe the characteristics of a linear bound automata model.  
 C. What are the ways in which we can represent Turing machines? Explain.  
 D. Consider the Turing machine with five states with initial state  $q_1$  and final state  $q_5$  and the transition table given below.

Present state	Tape symbol		
	$b$	$0$	$1$
$\rightarrow q_1$	$1Lq_2$	$0Rq_1$	
$q_2$	$bRq_3$	$0Lq_2$	$1Lq_2$
$q_3$		$bRq_4$	$bRq_5$
$q_4$	$0Rq_5$	$0Rq_4$	$1Lq_4$
$q_5$	$0Lq_2$		

Write the computation sequence of the input string 00.

- E. Write a note on unsolvable problems.  
 F. Design a Turing machine that accepts  $\{0^n 1^n \mid n \geq 1\}$

**Q.5 Attempt the following: (Any THREE)**

(15M)

- A. Construct a deterministic automaton equivalent to  $M = (\{q_0, q_1\}, \{0, 1\}, \delta, q_0, \{q_0\})$  where  $\delta$  is defined by its state table give below.

states/ $\Sigma$	$0$	$1$
$\rightarrow q_0$	$q_0$	$q_1$
$q_1$	$q_1$	$q_0, q_1$

- B. Find if the set  $L = \{ww \mid w \in \{a, b\}^*\}$  is not regular.  
 C. Write a note on multitape Turing machines.  
 D. Briefly describe Halting problem.  
 E. Describe the sets represented by the following regular expressions.  
 a.  $(a+b)^*(aa+bb+ab+ba)^*$   
 b.  $(aa)^*(aaa)^*$   
 c.  $(1+01+001)^*(\Lambda+0+00)$   
 d.  $a+b(a+b)^*$   
 e.  $ab^*a$

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