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 $\{\Lambda, 0, 00, 000, \ldots\}$ 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 (Λ) 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.

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

   i.   Define language.

   ii. What is the regular expression corresponding to the set of all the strings over {a, b} containing exactly 2a's.

   iii. Compare between Moore and Mealy Machines.

   iv. What is a sentence?

   v.   When do we say two regular expressions are equivalent?

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

A.   Define an automaton. Explain its various components.

B.   Construct a Mealy Machine which is equivalent to the Moore machine given by the following table.

Present state	Next State δ		Output
	a=0	a=1	
→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

C.   Construct a DFA accepting all the string w over {0, 1} such that the number of 1's in w is 3 mod 4.

D.   Construct a grammar G accepting the set L of all strings over {a, b} having more a's than b's.

E.   Construct a finite automaton equivalent to $(0+1)*(00+11)(0+1)*$

F.   State and prove Pumping Lemma for regular sets.

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

A.   Define pushdown automata. Explain its design.

B.   What is context free grammar? Construct a context free grammar G generating all integers.

C.   Define ambiguous grammar. Find if the following set of production of a grammar make it ambiguous?

   P: S → if b then U
   S → if b then U else S
   S → a
   U → for c do S
   U → a

D.   Show that L= { a_p | p is a prime} is not regular.

E.   Define Regular grammar. Also Generate the transition diagram for the following regular expressions.
   a. $a*b(a+b)*$
   b. $a*+b$

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 $\{0^n1^n \mid n \geq 1\}$

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 δ is defined by its state table give below.

states/Σ	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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