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 (\( \Lambda \)) 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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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?
   \[ P: S \rightarrow if \ b \ then \ U \\
   S \rightarrow if \ b \ then \ U \ else \ S \\
   S \rightarrow a \\
   U \rightarrow for \ c \ do \ S \\
   U \rightarrow a \]
D. Show that \( L = \{ a^p \mid p \text{ is a prime} \} \) is not regular.
E. Define Regular grammar. Also Generate the transition diagram for the following regular expressions.
   a. \( a*b(a+b)^* \)
   b. \( a^*+b \)
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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.

<table>
<thead>
<tr>
<th>Present state</th>
<th>Tape symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
</tr>
<tr>
<td>$\rightarrow q_1$</td>
<td>$1Lq_2$</td>
</tr>
<tr>
<td>$q_2$</td>
<td>$bRq_3$</td>
</tr>
<tr>
<td>$q_3$</td>
<td></td>
</tr>
<tr>
<td>$q_4$</td>
<td>$0Rq_5$</td>
</tr>
<tr>
<td>$q_5$</td>
<td></td>
</tr>
</tbody>
</table>

Write the computation sequence of the input string $00$.
E. Write a note on unsolvable problems.
F. Design a Turing machine that accepts $\{0^*1^n | n \geq 1\}$

Q.5 Attempt the following: (Any THREE) (15M)
A. Construct a deterministic automaton equivalent to $M=\langle \{q_0, q_1\}, \{0,1\}, \delta, q_0, \{q_0\} \rangle$ where $\delta$ is defined by its state table give below.

<table>
<thead>
<tr>
<th>states/$\Sigma$</th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rightarrow q_0$</td>
<td>$q_0$</td>
<td>$q_1$</td>
</tr>
<tr>
<td>$q_1$</td>
<td>$q_1$</td>
<td>$q_0, q_1$</td>
</tr>
</tbody>
</table>

B. Find if the set $L = \{ww | w \in \{a,b\}^* \}$ 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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