54CS

(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. The grammar G = ({S}, {a, b}, P, S) where P consists of
$S \rightarrow aSbb$, $S \rightarrow aab$
generates the language _____
a) $a^m b^n \mid m > n, m, n \geq 1$ b) $a^n b^{2n} \mid n \geq 1$
c) $a^m b^n \mid m < n, m, n \geq 1$ d) none of these

ii. The regular expression (P+Q)* is equal to
a) (P*+Q*)* b) (P*Q*)$^+$
c) (P*+Q*)$^+$ d) (P*+Q*)

iii. Pumping lemma for context-free languages are used to prove that certain languages are not context-free.
a) True b) False

iv. PDA stands for _____
a) pull down automata b) push direct automata
c) push down automata d) pull direct automata

v. In ___ machine, the output function Z(t) depends only on the present state and is independent of the current input.
a) Moore b) Mealy
c) Both a and b d) None of these

B. Fill in the blanks (Choose correct one from the pool) (5M)
(type 2, type 1, one, three, not regular, regular, a^+, a^*, initial, finial)

i. The regular expression aa^* is same as _____.
ii. A finite automaton can have more than one _____ state.
iii. The language L = {$a^p \mid p$ is a prime} is _____.
iv. Regular expression (aaa)* denotes the string x whose length is divisible by____
v. Context sensitive grammar is also known as _____ grammar

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

i. Non deterministic finite automaton
ii. Regular expression
iii. Acceptance by PDA
iv. Derivation tree
v. Decidable languages

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

A. What is finite automaton? Briefly explain with suitable example the acceptability of a string by a finite automaton.
B. Compare between Mealy and Moore models.
C. Construct DFA accepting all strings w over $\{a, b\}$ such that the number of a's in w is 3 mod 4.
D. Define Grammar. Also explain what is a language generated by a grammar. Give examples.
E. Compare between deterministic and non-deterministic finite automaton. Give suitable examples.
F. Write a note on operations on Languages.

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

A. Prove that $(a+b)^* = a^*(ba^*)^*$.
B. Explain with suitable example the leftmost derivation and rightmost derivations. Give example.
C. What is meant by ambiguity in context free grammar? Give example to explain the concept.
D. Write a note on Chomsky Normal Form.
E. State and prove pumping lemma for regular sets.
F. Draw the transition diagram for the expressions
   i. a^*+ba^* ii. a^*b+ba^*

Q.4 Attempt the following: (Any THREE) **(15M)**

A. Briefly explain the structure and operation of Push down automata.
B. Write a note on representation of Turing machine.
C. Design a Turing machine to recognize all strings consisting of even number of a's
D. Write a note on model of Linear Bounded Automaton.
E. Write a note on nondeterministic Turing machine.
F. Write a note on properties of recursive languages.

Q.5 Attempt the following: (Any THREE) **(15M)**

A. Briefly explain with example the steps of construction of minimum automaton.
B. Consider the grammar G given by
   $S \rightarrow 0SA_12 \quad S \rightarrow 012 \quad 2A_1 \rightarrow A_12 \quad 1A_1 \rightarrow 11$
   Test whether (a) $00112 \in L(G)$ (b) $001122 \in L(G)$
C. Construct a DFA with reduced states equivalent to the regular expression $10 + (0+11))0^*1$
D. Design a Turing Machine that accepts $\{a^n 1^n \mid n \geq 1\}$
E. Write a note on Universal Turing machines
F. Briefly outline the halting problem of Turing machine.