(Time: 2 Hours) **[Marks: 60]**

N.B.: 1) All Question carry equal Marks.
2) Question no. 1 is Compulsory.
3) Solve Three of the remaining Five questions.
4) Figures to the right indicate full marks.

Q.1) Answer the following questions **(ANY 3)**
(a) State the definition of Mealy and Moore machine along with its tuples. [05]
(b) Describe Chomsky Hierarchy. [05]
(c) Discuss the halting problem of Turing Machine. [05]
(d) Differentiate between Finite State Machine (FSM) and Push Down Automata (PDA). [05]

Q.2) (a) Design a Deterministic Finite Automata (DFA) over the $\Sigma = \{a, b\}$ for [10]
(a) $(ab)^n \; with \; n \geq 0$
(b) $(ab)^n \; with \; n \geq 1$
(b) Write a note on Non-Deterministic Finite Automata (NFA). [05]

Q.3) (a) Convert the following grammar into Chomsky Normal Form (CNF) [07]

$$S \rightarrow aAbB$$
$$S \rightarrow aA/a$$
$$S \rightarrow bB/b$$

(b) Construct the parse trees for the given strings using specified derivation format for given grammar G where $G = (\{S, A, B\}, \{a, b\}, P, \{S\})$ [08]

$$P = S \rightarrow aB, \quad S \rightarrow bA,$$
$$A \rightarrow a, \quad A \rightarrow aS,$$
$$A \rightarrow bAA, \quad B \rightarrow b,$$
$$B \rightarrow bS, \quad B \rightarrow aBB$$

Strings:
(a) aaabbb (rightmost derivation)
(b) aababb (leftmost derivation)

Q.4) (a) Design a PDA for the language $L = \{a^n b^{2n} / n \geq 1\}$ [10]
(b) What is ambiguous grammar? Explain with an example. [05]

Q.5) (a) Describe the language denoted by the following regular expressions where $L \subseteq \{a, b\}^*$ [05]
(a) $(a + b)^* b$
(b) $(b^* ab^* ab^* ab^*)^*$
(c) $(a + b)^* ba$
(d) $b^* a *$
(e) $(a + b)^* ab + a^*$
(b) Design a TM for the language $L = \{a^n b^n / n \geq 1\}$ [10]

Q.6) Write short notes on **(Any Three):** [15]
(a) Phases of a Compiler
(b) Variants of TM.
(c) Minimization of DFA.
(d) Regular Expressions and Regular Grammar

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