(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. An automaton in which the output depends only on the states of the machine is called a _____ Machine
   a) Mealy b) Moore
   c) Turing Machine d) All of these

ii. A final state is also called _____ state.
   a) Non-accepting b) key
   c) accepting d) none of these

iii. A type 2 grammar is also called _____ grammar
   a) Context free b) Context sensitive
   c) Free d) natural

iv. (a+a*)* is equivalent to
   a) a(a*)* b) a*
   c) aa* d) none of these

v. A terminal string $w \in L(G)$ is ambiguous if there exists _____ or more derivation trees for w.
   a) one b) two
   c) neither a nor b d) either a or b

B. Fill in the blanks (Choose correct one from the pool) **(5M)**

(pumping lemma, pigeonhole principle, Turing machine, reduction, production, stack, PDA, finite automata, regular expression, list)

i. _____ can be used to prove that certain sets are not regular.
ii. A pushdown automata contains _____ besides a input tape, a input alphabet, a finite state control, a set of final states and an initial state.
iii. Type-0 languages can be accepted by _____.
iv. _____ describe the languages accepted by finite state automata and are useful for representing certain sets of strings in an algebraic form.
v. Context free languages (Type-2) can be accepted by _____

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

i. Nondeterministic finite state machine
ii. Grammar
iii. Regular set
iv. Chomsky Normal Form
v. Language generated by the grammar L(G)

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

A. Explain the process of construction of minimum automaton. Give suitable example to explain the concept.
B. Construct a DFA accepting all strings over $\{a, b\}$ ending in ab.
C. Construct a grammar G generating $\{xx \mid x \in \{a, b\}^*\}$
D. If G = ({S}, {0,1}, {S $\rightarrow$ 0S1, S $\rightarrow \Lambda$}, S), find L(G).
E. Define Ambiguous Grammar. Find if the grammar G with the following productions is ambiguous?
   S $\rightarrow$ SbS
   S $\rightarrow a$
F. Write a note on classification of Grammar.

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

A. State and prove pumping lemma for regular sets.
B. Give a regular expression for representing the set L of strings in which every 0 is immediately followed by at least two 1's.
   Also prove that the regular expression R=λ+1*(011)*(1*(011)*)* also describes the same set of strings.
C. Explain the steps for reduction of grammar to Chomsky normal form.
D. Convert the nondeterministic systems to deterministic systems.
E. State and prove Arden's theorem.
F. What is a derivation tree? Generate the derivation tree for the string *aabaa* using the grammar G with following set of productions
   $S \rightarrow aAS \mid a \mid SS$
   $A \rightarrow SbA \mid ba$

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

A. Explain the Linear Bound Automata Model.
B. Construct a PDA accepting L= $\{wcw^T \mid w \in \{a, b\}^*\}$
C. Write a note on Halting problem of Turing Machine.
D. Design a Turing Machine that accepts $\{0^n1^n \mid n \geq 1\}$
E. What is Turing Machine? Design a Turing Machine to recognize all strings consisting of an even number of 1's.
F. Explain the structure and operation of pushdown automata.

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

A. Construct a DFA with reduced states equivalent to the regular expression 10+(0+11)0*1

B. Let G be the grammar with productions

$S \rightarrow 0B \mid 1A$,

$A \rightarrow 0 \mid 0S \mid 1AA$

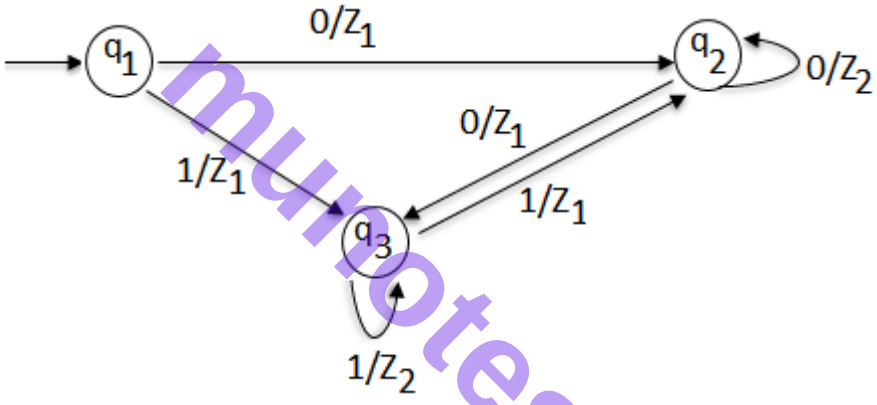
$B \rightarrow 1 \mid 1S \mid 0BB$

For the string 00110101, find

(a) the leftmost derivation

(b) rightmost derivation

C. Consider a Mealy machine represented by the figure given below. Construct a Moore machine equivalent to this Mealy machine.



D. What is regular set? Is L= $\{a^{2n} \mid n \geq 1\}$ regular?

E. Construct the finite automaton equivalent to the regular expression (0+1)*(00+11)(0+1)*

F. Write a note on operations on language.

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