SEMESTER END EXAMINATIONS – AUGUST 2024

Program	:	B.E :- Computer Science and Engineering	Semester	:	IV
Course Name	:	Finite Automata and Formal Languages	Max. Marks	:	100
Course Code	:	CS45	Duration	:	3 Hrs

Instructions to the Candidates:

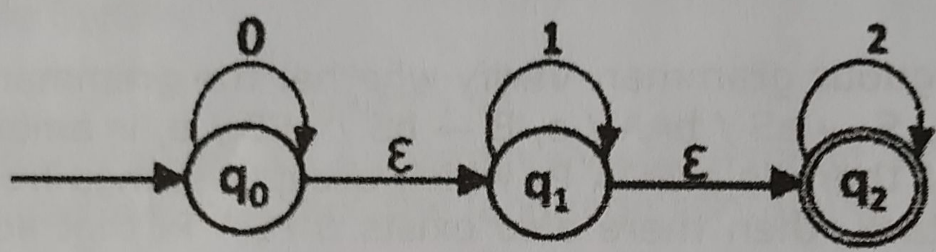
- Answer one full question from each unit.

UNIT - I

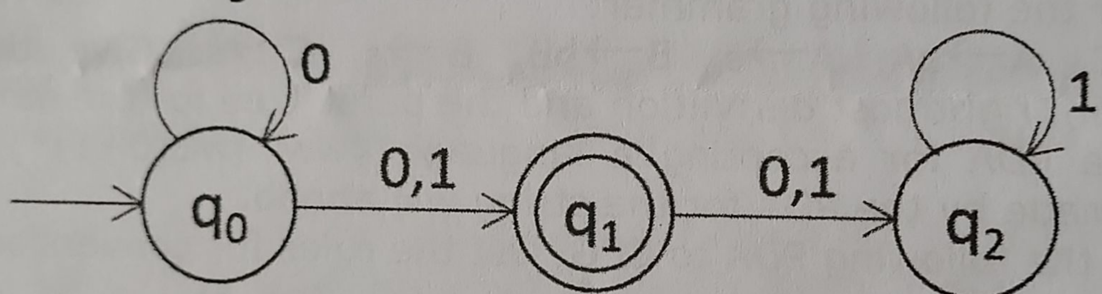
1. a) Define DFA. Design a DFA which accepts all strings with a substring 01. CO1 (06)

   b) Prove that language L is accepted by some ε-NFA if and only if L is accepted by some DFA. CO1 (06)

   c) Convert the following ε-NFA to DFA. CO1 (08)



2. a) Convert the following NFA to DFA. CO1 (08)



   b) If $D=(Q_D,\Sigma,\phi_D,\{q_0\},F_D)$ is the DFA constructed from NFA $N=(Q_N,\Sigma,\phi_N,\{q_0\},F_N)$ by the subset construction. Then show that $L_D = L_N$. CO1 (06)

   c) Obtain a DFA to accept CO1 (06)

      i. L={n_a(w)mod 5=0} on Σ ={a,b}

      ii. L={n_a (w)mod 3≠0} on Σ ={a}

UNIT - II

3. a) Obtain the regular expressions to describe the following languages. CO2 (06)

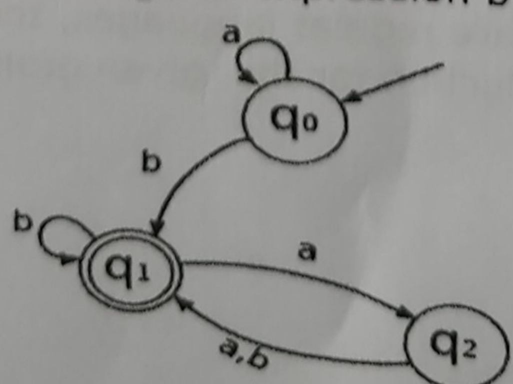
   (i) Strings of a's and b's whose first and last symbols are the same.

   (ii) L= {$a^n b^n$, n>=1}

   (iii) Strings of 0's and 1's whose lengths are multiples of 3.

   b) Prove that every language defined by a regular expression is also defined by a finite automaton. CO2 (07)

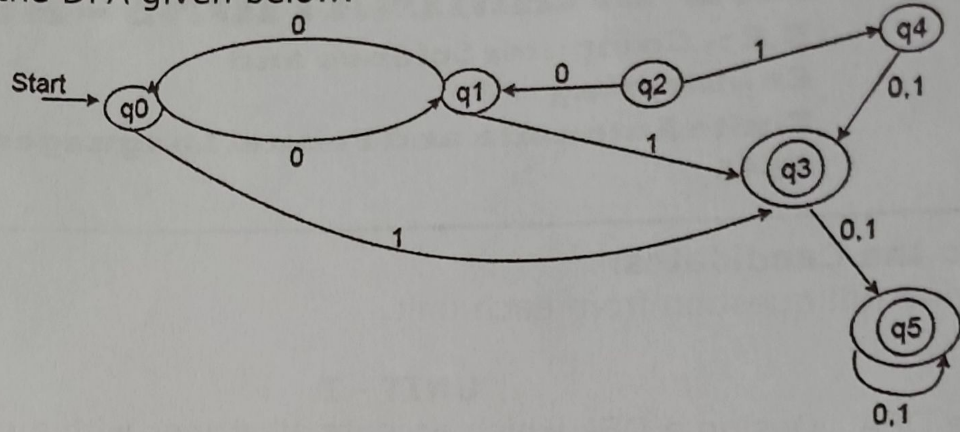
   c) Convert the following into a regular expression by eliminating states. CO2 (07)



4. a) Prove that regular languages are closed under union, complementation and difference operations. CO2 (06)

   b) State the pumping lemma for regular languages. Prove that the set of strings of 0's and 1's of the form ww is not a regular language. CO2 (05)

   c) Minimize the DFA given below. CO2 (09)



UNIT - III

5. a) Define PDA. Construct DPDA to accept strings with $L=\{x \in \{a, b\}^* \mid n_a(x) = n_b(x)\}$. Show the moves for the input string abbaba. CO3 (07)

   b) Define ambiguous grammar. Verify whether the grammar $S \rightarrow aB / bA$, $S \rightarrow aS / bAA / a$, $B \rightarrow bS / aBB / b$, is ambiguous? CO3 (05)

   c) Prove that if there is a PDA P_N which accepts strings from a language L by empty stack, then there also exists a PDA P_F that accepts L by final state. CO3 (08)

6. a) Consider the following grammar: $S \rightarrow ABC$, $A \rightarrow aA$, $A \rightarrow \varepsilon$, $B \rightarrow bB$, $B \rightarrow \varepsilon$, $C \rightarrow \varepsilon$. Give the leftmost derivation, rightmost derivation and the parse tree for the string aabbba. CO3 (06)

   b) Design a PDA for accepting a language $\{ww^R \mid w \in (0+1)^*\}$. Trace the moves made by the PDA for the string w= abbab. CO3 (08)

   c) Convert the following PDA to CFG. List the rules for conversion. CO3 (06)

$$
\begin{aligned}
\delta(q, 1, Z_0) &= \{(q, XZ_0)\} \\
\delta(q, 1, X) &= \{(q, XX)\} \\
\delta(q, 0, X) &= \{(p, X)\} \\
\delta(q, \epsilon, X) &= \{(q, \epsilon)\} \\
\delta(p, 1, X) &= \{(p, \epsilon)\} \\
\delta(p, 0, Z_0) &= \{(q, Z_0)\}
\end{aligned}
$$

UNIT- IV

7. a) Obtain the grammar in CNF: CO4 (07)

   $S \rightarrow 0A \mid 1B$

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

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

   b) Prove that if L and M are regular languages, then so is $L \cap M$. CO4 (07)

   c) Eliminate all unit production for the given grammar: CO4 (06)

   $S \rightarrow AB$

   $A \rightarrow a$

   $B \rightarrow C \mid b$

   $C \rightarrow D$

   $D \rightarrow E \mid bC$

   $E \rightarrow d \mid Ab$

8. a) Eliminate all ε production for the given grammar: CO4 (06)
   S → ABC | bD
   A →BC|b
   B → b | ε
   C→ c | ε
   D → d

   b) For the given grammar: CO4 (10)
   S->ABC|BaB
   A->aA|BaClaaa
   B->bBbla|D
   C->CA|AC
   D->E
   i) Eliminate E-productions
   ii) Eliminate unit productions in the resulting grammar.
   iii) Eliminate any useless symbols in the resulting grammar.

   c) Define the following: CO4 (04)
   i. Unit production
   ii. CNF
   iii. Null-able production
   iv. Reachable Symbol.

UNIT - V

9. a) Write the properties of recursive & recursively enumerable languages. CO5 (05)
   b) Obtain a Turing machine to accept the language containing strings of 0's and 1's ending with 011. CO5 (10)
   c) Define a Turing Machine. With a neat diagram explain the working of a Turing Machine. CO5 (05)

10. a) Explain in detail about variations of the TM? CO5 (08)
   b) Obtain a Turing machine to accept the language L= { w | w is odd and Σ € { a , b, c } CO5 (06)
   c) Define PCP. Verify whether the following lists have a PCP solution. CO5 (06

$$\binom{abab}{ababaaa}, \binom{aaabbb}{bb}, \binom{aab}{baab}, \binom{ba}{baa}, \binom{ab}{ba}, \binom{aa}{a}.$$

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