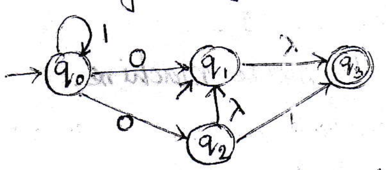
Automata

1. Define : Automata, DFA, NFA, transition system.
2. Consider the system given in Fig bellow.



• Determine the acceptability of the string 101011
111010.

3. Prove that every NFA, there exists a DFA.
4. Write an algorithm to convert a given NFA to DFA.
5. Construct a deterministic automata equivalent to $M = (\{q_0, q_1\}, \{0, 1\}, \delta, \{q_0\})$
   δ is given by the following state table :

state	0	1
$\rightarrow q_0$	q_0	q_1
q_1	q_1	q_0, q_1

6. Find a DFA equivalent to the following NDFAS

i)

state	a	b
$\rightarrow q_0$	q_0, q_1	q_2
q_1	q_0	q_1
q_2	—	q_0, q_1

ii)

State	a	b
$\rightarrow q_0$	$q_0 q_1$	q_0
q_1	q_2	q_1
q_2	q_3	q_3
q_3	—	q_2

7. What are the differences between Mealy machine and Moore machine.
8. Write steps to convert Mealy machine to moore machine and vice-versa.
9. Convert the following Moore machine to Mealy machine :

i)

Present state	Next state $a=0$	Next state $a=1$	λ
$\rightarrow q_0$	q_3	q_1	0
q_1	q_1	q_2	1
q_2	q_2	q_3	0
q_3	q_3	q_0	0

ii)

Present state	Next state $a=0$	Next state $a=1$	output λ
$\rightarrow q_0$	q_1	q_2	1
q_1	q_3	q_2	0
q_2	q_2	q_1	1
q_3	q_0	q_3	1.

10. Convert the following mealy machine to moore machine.

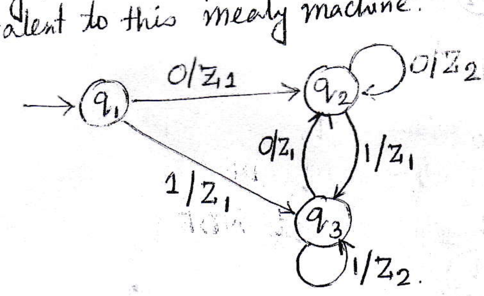
i)

Present state	Next state $a=0$	Next state $a=1$
$\rightarrow q_1$	$q_3, 0$	$q_2, 0$
q_2	$q_1, 1$	$q_4, 0$
q_3	$q_2, 1$	$q_1, 1$
q_4	$q_4, 1$	$q_3, 0$.

ii)

Present state	Next state $a=0$	Next state $a=1$
$\rightarrow q_1$	$q_1, 1$	$q_2, 0$
q_2	$q_4, 1$	$q_4, 1$
q_3	$q_2, 1$	$q_3, 1$
q_4	$q_3, 0$	$q_1, 1$.

11. Consider a Mealy machine represented by figure bellow. Construct a Moore machine equivalent to this mealy machine.



12. Write an algorithm to find minimum state automata. Apply your algorithm to minimize the following DFAs

i)

State	$x=0$	$x=1$
$\rightarrow q_0$	q_1	q_5
q_1	q_6	q_2
q_2	q_0	q_2
q_3	q_2	q_6
q_4	q_7	q_5
q_5	q_2	q_6
q_6	q_6	q_4
q_7	q_6	q_2

ii)

State	$x = a$	$x = b$
$\to q_0$	q_1	q_0
q_1	q_0	q_2
q_2	q_3	q_1
(q_3)	q_3	q_0
q_4	q_3	q_5
q_5	q_6	q_4
q_6	q_5	q_6
q_7	q_6	q_3

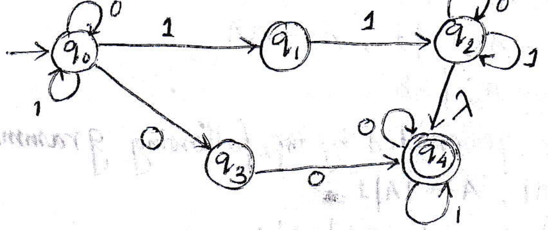
iii)

State	$x = a$	$x = b$
$\to q_0$	q_0	q_3
q_1	q_2	q_5
q_2	q_3	q_4
q_3	q_0	q_5
q_4	q_0	q_6
q_5	q_1	q_4
(q_6)	q_1	q_3

struct a Moore

13. Construct a NFA accepting the set of all strings over $\{a, b\}$ ending in aba. Use it to construct a DFA.

14. Construct a DFA equivalent to NDFA given as:



Apply yours

15. $M = (\{q_1, q_2, q_3\}, \{0, 1\}, \delta, \{q_1\})$ is a nondeterministic finite automata, where δ is given by

$$\delta(q_1, 0) = \{q_2, q_3\} \qquad \delta(q_1, 1) = \{q_1\}$$
$$\delta(q_2, 0) = \{q_1, q_2\} \qquad \delta(q_2, 1) = \phi$$
$$\delta(q_3, 0) = \{q_2\} \qquad \delta(q_3, 1) = \{q_1, q_2\}.$$

construct an equivalent DFA.

16. Construct a transition system which can accept string over alphabet $a, b, \ldots,$ containing either 'cat' or 'rat'.

17. Construct a mealy machine which can output EVEN, ODD according as the total number of 1's encountered is even or odd. The input symbols are 0 and 1. Convert it into a Moore machine.

18. Define the following terms:

Grammar, production, sentential form, Language, sentences.

19. If $G = (\{S\}, \{0,1\}, \{S \to 0S1, S \to \lambda\}, S)$, Find $L(G)$.

20. If $G = (\{S\}, \{a\}, \{S \to SS\}, S)$, find $L(G)$.

21. If $G = (\{S, C\}, \{a, b\}, P, S)$, where P consists of $S \to aCa$, $C \to aCa|b$. Find $L(G)$.

22. If G is $S \to aS|bS|a|b$, find $L(G)$.

23. If L be the set of all palindromes over $\{a,b\}$. Construct G generating L.

24. Construct a grammar generating $L = \{wcw^T | w \in \{a,b\}^*\}$.

25. Find a grammar generating $L = \{a^n b^n c^i | n \geq 1, i \geq 0\}$.

26. Find a grammar generating $\{a^j b^n c^n | n \geq 1, j \geq 0\}$

27. Let $G = (\{S, A_1\}, \{0,1,2\}, P, S)$ where P consists of $S \to 0SA_12$, $S \to 012$, $2A_1 \to A_12$, $1A_1 \to 11$. Show that $L(G) = \{0^n 1^n 2^n | n \geq 1\}$.

28. Construct a grammar G generating $\{a^n b^n c^n | n \geq 1\}$

29. Construct a grammar G generating $\{xx | x \in \{a,b\}^*\}$.

30. Let $G = (\{S, A_1, A_2\}, \{a, b\}, P, S)$ where P consist of $S \to aA_1A_2a$, $A_1 \to bA_1A_2b$, $A_2 \to A_1ab$, $aA_1 \to baa$, $bA_2b \to abab$. Test whether $w = baabbabaaabbaba$ is in $L(G)$.

31. Write a short note on chomsky classification of Grammar.

32. Find the highest type of Grammar which can be applied to the following grammar.

(a) $S \to Aa$, $A \to c|Ba$, $B \to abc$.

(b) $S \to ASB|d$, $A \to aA$

(c) $S \to AS|ab$.

33. Find the language generated by the following grammars:

a) $S \to 0S1|0A1$, $A \to 1A|1$.

b) $S \to 0A|1S|0|1$, $A \to 1A|1S|1$.

c) $S \to 0S1|0A1$, $A \to 1A0|10$.

34. Construct the grammar accepting each of the following sets:

a) The set of all strings over $\{0,1\}$ consisting of equal number of 0s and 1s.

b) $\{0^n 1^m 0^m 1^n | m, n \geq 1\}$.

c) $\{0^n 1^{2n} | n \geq 1\}$

d) $\{0^n 1^n | n \geq 1\} \cup \{1^m 0^m | m \geq 1\}$.

e) $\{0^n 1^m 0^n | m, n \geq 1\}$.

ns.

n).

$Ca, C \to aCa|b$.

G generating L.

$\}^* \}$.

$\geq 0\}$.

$\geq 0\}$

$S \to 0SA, 2$,

${}^{n}1^{n}2^{n}|n \geq 1\}$.

$\}^* \}$.

$S \to aA_1A_2a$,

ab. Test whether

rammar

applied to the

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35. construct a (i) context sensitive but not context free ii) context free but not regular (iii) a regular grammar to generate $\{a^n | n \geq 1\}$

36. Construct a grammar that generates all even integers upto 998.

37. Construct content-free grammar to generate

   a) $\{0^m 1^n | m \neq n, m, n \geq 1\}$

   b) $\{0^m 1^n | 1 \leq m \leq n\}$

   c) The set of all strings over $\{a, b\}$ containing twice as many a's as b's.

38. Construct regular grammar to generate

   a) $\{a^{2n} | n \geq 1\}$

   b) The set of all strings over $\{a, b\}$ ending in a.

   c) The set of all strings over $\{a, b\}$ beginning with a.

   d) $\{(ab)^n | n \geq 1\}$.

39. Design grammar to generate the languages:

   a) $\{a\}^+$

   b) $\{a\}^*$

   c) $aa(a+b)^+$

   d) $\{a^n b^n | n \geq 0\}$

   e) $\{a^n b a^n | n \geq 0\}$

   f) The set of all balanced parenthesis.

   g) $\{a^n b^n c^m d^m | n, m \geq 2\}$

   h) set of all non palindromes.

   i) $\{a^n b^n c^m | n \neq m\}$.

40. A grammar $G = (\{S, A, B\}, \{a, b, c\}, P, S)$, where P consists of $S \to ABSc | Abc$, $BA \to AB$, $Bb \to bb$, $Ab \to ab$, $Aa \to aa$

   i) Derive the following strings by using G: abc, aaabbbccc

   ii) Show that the following strings are not derivable by G. aabc, abbc.

41. A grammar $G = (\{S, T\}, \{a, b, c\}, P, S)$, where P consists of $S \to SS | aST | a$, $T \to bB | b$, $B \to Sc | c$. Determine whether the following strings are derivable: aaabac, abaaacb.

42. Define: RE. What is the advantage of using R.E.

43. What is Regular set.

44. Describe the following set by R.E.

   (a) $\{101\}$ (b) $\{abba\}$ (c) $\{01, 10\}$ (d) $\{ab, a, b, ba\}$

   (e) $\{\lambda, 0, 00, 000, \ldots\}$ (f) $\{1, 11, 111, \ldots\}$

   (g) {set of all strings of 0's and 1's ending in 00}

   (h) {set of all strings of 0's and 1's beginning with 0 and ending with 1}

   (i) $\{\lambda, 11, 1111, 111111, \ldots\}$

45. State & prove Arden's theorem.

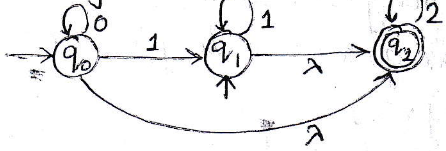
46. Give an R.E. for representing the set of all strings in which every 0 is immediately followed by at least two 1's. Prove that the R.E. $R = \lambda + 1^*(011)^*(1^*(011)^*)^*$ also describe the same set.

47. Prove $(1+00^*1) + (1+00^*1)(0+10^*1)^*(0+10^*1) = 0^*1(0+10^*1)^*$.

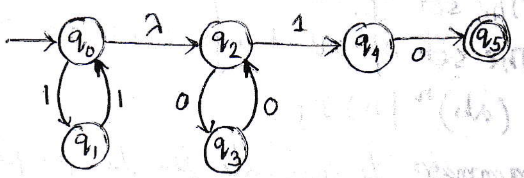
48. Prove that every regular expression can be recognized by a transition System.

49. Write steps to remove λ-moves. Hence remove λ-moves from the following transition systems.

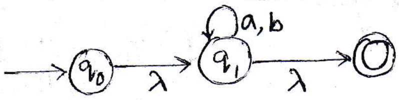
i)



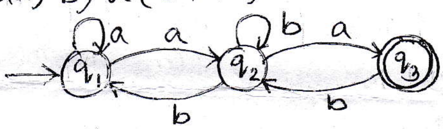
ii)



iii)

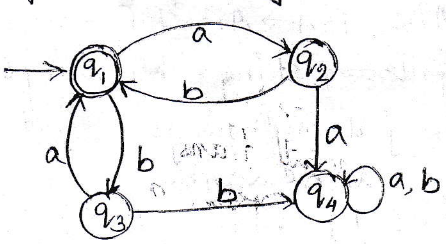


50. Consider the transition system. Prove that the strings recognized are $(a + a(b+aa)^*b)^*a(b+aa)^*a$

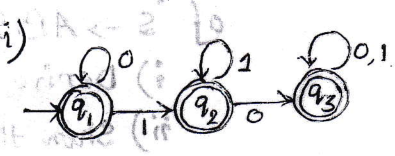


51. Find R.E. from the following :

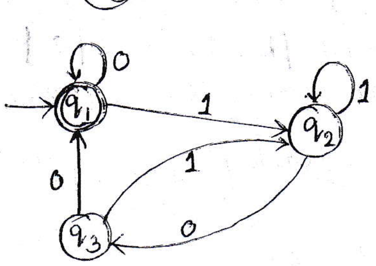
i)



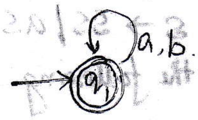
ii)



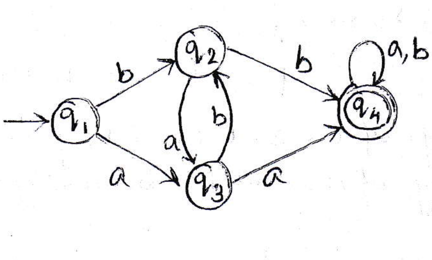
iii)



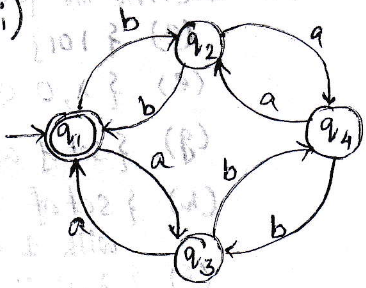
iv)



iv)



vi)



52. Co…

53. Constru…

54. Write S…
Hence …

i)

ii)

55. Write …
that …

56. Write …
Hence …
the …

57. Write …
Hence …
$G = ($…

58. If a …
R.E. …

59. Find …

60. Con…
(i)
(iii)
(v)
(vii)

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$0^*1(0+10^*1)^*$.
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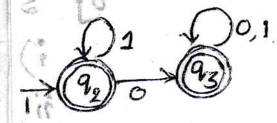
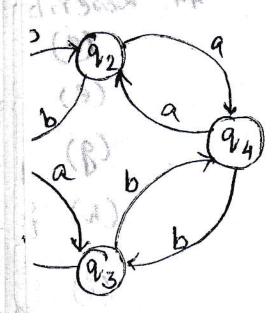


)a,b.



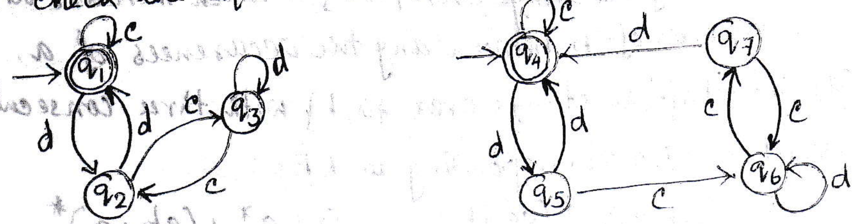
52. Construct an Finite automata equivalent to the R.E.

$$(0+1)^*(00+11)(0+1)^*$$

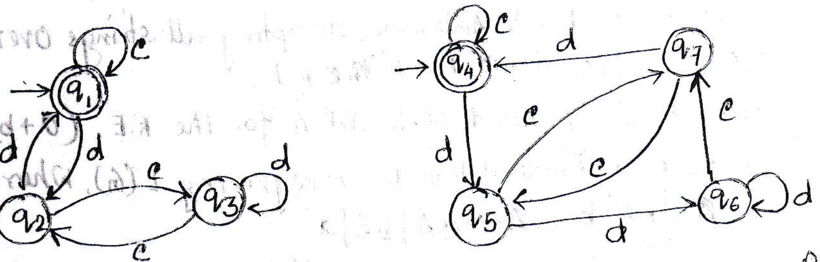
53. Construct a reduced state DFA equivalent to R.E. $10+(0+11)0^*1$.

54. Write steps to check two given automata are equivalent or not. Hence check the equivalence of the following pairs of automata.

i)



ii)



55. Write steps to check the equivalence of two R.E. Hence Prove that $(a+b)^* = a^*(ba^*)^*$

56. Write algorithm to generate regular grammar from transition system. Hence apply your algorithm to generate regular grammar generating the regular set $a^*b(a+b)^*$.

57. Write an algorithm to generate transition system from regular grammar $L(G)$, where Hence construct a transition system accepting $L(G)$, where $G = (\{A_0, A_1\}, \{a, b\}, \{A_0 \to aA_1, A_1 \to bA_1, A_1 \to a, A_1 \to bA_0\}, A_0)$.

58. If a regular grammar G is given by $S \to aS|a$, find the R.E. accepting $L(G)$.

59. Find R.E. for the following sets:

i) $\{0, 1, 2\}$

ii) $\{1^{2n+1} \mid n > 0\}$

iii) $\{w \in \{a, b\}^* \mid w$ contains only one $a\}$

iv) The set of all strings over $\{0,1\}$ which has at most two 0s.

v) $\{a^2, a^5, a^8, \ldots\}$

vi) $\{a^n \mid n$ is divisible by 2 or 3 or $n = 5\}$

60. Construct transition system equivalent to the R.Es:

(i) $(ab+a)^*(aa+b)$
(ii) $(a^*b + b^*a)^*a$
(iii) $a^* + (ab+a)^*$
(iv) $a(a+b)^*ab$
(v) $a^*b + b^*a$
(vi) $(aa+b)^*(bb+a)^*$
(vii) $(ab+c^*)^*b$
(viii) $a+bb+bab^*a$.

61. Find R.E. representing the following sets:

(a) The set of all strings over $\{0,1\}$ having at most one pair of 0's or atmost one pair of 1's.

(b) The set of all strings over $\{a,b\}$ in which the number of occurence of a is divisible by 3.

(c) The set of all strings over $\{a,b\}$ in which there are at least two occurences of b between any two occurences of a.

(d) The set of all strings over $\{a,b\}$ with three consecutive b's.

62. Construct a DFA corresponding to R.Es:

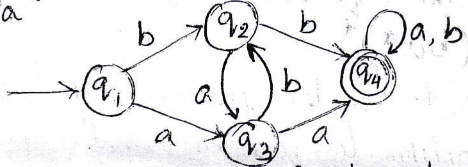
i) $(ab+a)^*(aa+b)$ ii) $a^* + (ab+a)^*$

63. Construct a Finite Automata accepting all strings over $\{0,1\}$ ending in 010 or 0010. Hence Find the R.E.

64. Construct a reduced state DFA for the R.E. $(a+b)^* abb$.

65. Construct a Finite Automata recognizing $L(G)$, where G is the grammar $S \rightarrow aS \mid bA \mid b$, $A \rightarrow aA \mid bS \mid a$.

66. Find a regular grammar accepting the set recognize by the finite automata



67. Construct a deterministic finite automata equivalent to the grammar $S \rightarrow aS \mid bS \mid aA$, $A \rightarrow bB$, $B \rightarrow aC$, $C \rightarrow \lambda$.

68. Construct a grammar G generating all integers with sign.

69. What is derivation tree? What do you mean by left derivation and right derivation?

70. What do you mean by ambiguous grammar?

71. If G is the grammar $S \rightarrow SbS \mid a$, show that G is ambiguous.

72. If G is the grammar $S \rightarrow S+S \mid S*S \mid a \mid b$, show that G is ambiguous.

73. A goods train may have one or two engines at the front, followed by one or more compartments, followed by a guard van. Design a R.E. to represent a goods train.

74. Design a R.E. for the set of strings that consisting of alternating 0's & 1's.

75. Design R.E., grammar and transition system for each of the languages:

i) All strings of length greater than two.

ii) All strings begining with 11.

iii) All strings not beginning with 11.

iv) All strings which does not have three consecutive 0s.

v) A

vi) All

vii) All st

viii) All str

ix) All st

x) All vo

76. What is

77. How tu

78. Design

79. Design

80. Desig

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ii) c

iii) c

iv)

v)

vi)

vii)

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xv

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xvi

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ber of occurence
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a.
secutive b's.
6
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0,1} ending in
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G is the grammar
by the finite
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derivation and
ambiguous.
at G is ambiguous.
ollowed by one or
R.E. to represent
ernating 0's & 1's.
each of the
tive 0s.

v) All strings which having a 1 as the third symbol from right end.
vi) All strings having even number of 0's and 1's.
vii) All strings having 101 as a substring.
viii) All strings having total number of 1's divisible by 5.
ix) All strings having total number of 1's not divisible by 5.
x) All valid C Language variable length.

76. What is Turing Machine? What is universal Turing machine?

77. How turing machine differs from FSM?

78. Design a TM to recognize the language $\{1^n 2^n 3^n \mid n \geq 1\}$

79. Design a TM that recognize the language $\{0^n 1^n \mid n \geq 1\}$.

80. Desig TM's that
   i) accept all strings over $\{0,1\}$ containing even number of 1's.
   ii) compute addition of two positive integers.
   iii) compute proper subtraction of two positive integer m, n. $m-n$ is defined as $m-n$ if $m > n$ and 0 if $m \leq n$.
   iv) replaces first 0 by 1 and does not change any other symbol.
   v) replaces all 0s by 1s and does not change any of the 1s.
   vi) replaces all but the leftmost 1 with 0 and does not change other symbo
   vii) replaces first two consecutive 1s by 0s and does not change other symbol
   viii) recognizes the set of all bit strings end with a 0.
   ix) recognizes the set of all bit strings containing atleast two 1s.
   x) recognizes the set of all bit strings containing an even number of 1s.
   xi) recognizes the set $\{0^{2n} 1^n \mid n \geq 0\}$.
   xii) computes the function $f(n) = n+2$, for all nonnegative integers
   xiii) computes the function $f(n_1, n_2) = n_1 + n_2 + 1$ for all positive intege
   xiv) compute the function $f(n) = 3$ if $n \geq 5$ and $f(n) = 0$ if $n = 0,1,2,3,4$.
   xv) Compute the function $f(n) = n \bmod 3$
   xvi) compute the function $f(n) = n-3$ if $n \geq 3$ and $f(n) = 0$ for $n = 0, 1, 2$.
   xvii) compute the function $f(n_1, n_2) = n_1 * n_2$, for all positive integers.