TOC

1. State whether the following statements are TRUE or FALSE:
   A minimal DFA that is equivalent to an NDFA with n nodes has always 2^n states

[Gate 1987]

2. Let L be the language of all binary strings in which the third symbol from the right is a 1. Give a non-deterministic finite automaton that recognizes L. How many states does the minimized equivalent deterministic finite automation have? Justify your answer briefly?

[Gate 1991]

3. Draw the state transition of a deterministic finite state automaton which accepts all strings from the alphabet {a, b}, such that no string has 3 consecutive occurrences of the letter b.

[Gate 1993]

4. State True or False with one line explanation
   A FSM (Finite State Machine) can be designed to add two integers of any arbitrary length (arbitrary number of digits).

[Gate 1994]

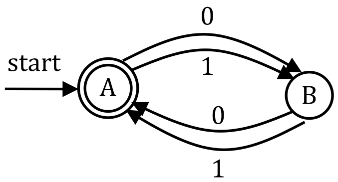
5. A finite state machine with the following state table has a single input a and a single out z.

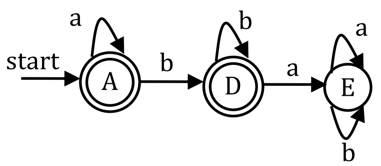
Present state	Next state, z	
	X=1	X=0
A	D,0	B,0
B	B,1	C,1
C	B,0	D,1
D	B,1	C,0

If the initial state is unknown, then the shortest input sequence to reach the final state C is:
(A) 01
(B) 10
(C) 101
(D) 110

[Gate 1995]

6. Given below are the transition diagrams for two finite state machines M_1 and M_2 recognizing languages L_1 and L_2 respectively.





A. Display the transition diagram for a machine that recognizes $L_1 . L_2$, obtained from transition diagrams for M_1 and M_2 by adding only ε transitions and no new states

B. Modify the transition diagram obtained in part (a) obtain a transition diagram for a machine that recognizes $(L_1 . L_2)^*$ by adding only ε transitions and no new states. (Final states are enclosed in double circles).

[Gate 1996]

7. Consider the following state table for a sequential machine. The number of states in the minimized machine will be

		Input	
		0	1
Present State	A	D, 0	B, 1
	B	A, 0	C, 1
	C	A, 0	B, 1
	D	A, 1	C, 1
		Next state, Output	

(A) 4
(B) 3
(C) 2
(D) 1

[Gate 1996]

8. Construct a finite state machine with minimum number of states, accepting all strings over (a,b) such that the number of a's is divisible by two and the number of b's is divisible by three.

[Gate 1997]

9. Given that L is a language accepted by a finite state machine, show that L^P and L^R are also accepted by some finite state machines, where

$L^P = \{s | ss' \in L \text{ some string } s'\}$

$L^R = \{ s | s \text{ obtained by reversing some string in } L\}$

[Gate 1997]

10. Which of the following set can be recognized by a Deterministic Finite state Automaton?

(A) The numbers $1, 2, 4, 8, \cdots 2^n, \cdots$ written in binary
(B) The numbers $1, 2, 4, 8, \cdots 2^n, \cdots$ written in unary
(C) The set of binary string in which the number of zeros is the same as the number of ones.
(D) The set $\{ 1, 101, 11011, 1110111, \cdots \}$

[Gate 1998]

11. Let L be the set of all binary strings whose last two symbols are the same. The number of states in the minimal state deterministic finite state automaton accepting L is

(A) 2
(B) 5
(C) 8
(D) 3

[Gate 1998]

12. Design a deterministic finite state automaton (using minimum number of states) that recognizes the following language:
$L = \{\omega \in \{0,1\}^* \mid \omega$ Interpreted as binary number (ignoring the leading zeros) is divisible by five $\}$

[Gate 1998]

13. Consider the regular expression $(0+1)(0+1)\cdots N$ times. The minimum state finite automaton that recognizes the language represented by this regular expression contains
(A) n states
(B) n+1 states
(C) n+2 states
(D) None of the above

[Gate 1999]

14. Given an arbitrary non-deterministic finite automaton (NFA) with N states, the maximum number of states in an equivalent minimized DFA at least
(A) N^2
(B) 2^N
(C) 2N
(D) N!

[Gate 2001]

15. Consider a DFA over $\sum = \{a, b\}$ accepting all strings which have number of a's divisible by 6 and number of b's divisible by 8. What is the minimum number of states that the DFA will have?
(A) 8
(B) 14
(C) 15
(D) 48

[Gate 2001]

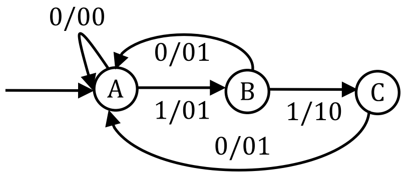
16. Construct DFA's for the following languages:
(A) $L = \{\omega | \omega \in \{a,b\}^*, w \text{ has baab as a substring}\}$
(B) $L = \{\omega | \omega \in \{a,b\}^*, w \text{ has an odd number of a's and an odd number of b's}\}$

[Gate 2001]

17. The smallest finite automaton which accepts the languages { x| length of x is divisible by 3} has
(A) 2 states
(B) 3 states
(C) 4 states
(D) 5 states

[Gate 2002]

18. The finite state machine described by the following state diagram with A as starting state, where an arc label is and x stands for 1-bit input and y stands for 2-bit output



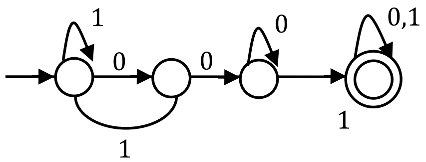
(A) Outputs the sum of the present and the previous bits of the input
(B) Outputs 01 whenever the input sequence contains 11
(C) Outputs 00 whenever the input sequence contains 10
(D) None of the above

[Gate 2002]

19. We require a four state automaton to recognize the regular expression (a/b) ∗ abb
A. Give an NFA for this purpose
B. Give a DFA for this purpose

[Gate 2002]

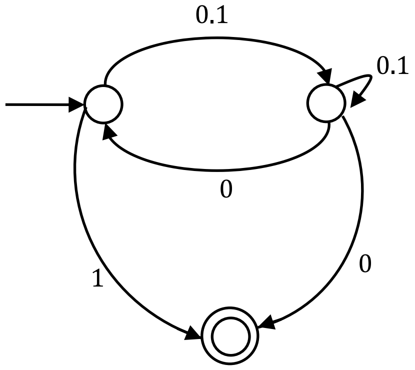
20. Consider the following deterministic finite state automaton M.



Let S denote the set of seven bit binary strings in which the first, the fourth, and the last bits are 1. The number of strings in S that are accepted by M is
(A) 1
(B) 5
(C) 7
(D) 8

[Gate 2003]

21. Consider the NFA M shown below.

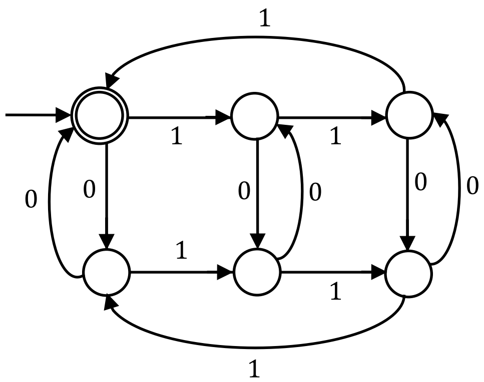


Let the language accepted by M be L. Let L_1 be the language accepted by the NFA M_1 obtained by changing the accepting state of M to a non-accepting state and by changing the non-accepting states of M to accepting states. Which of the following statements is true?

(A) $L_1 = \{0, 1\}^* - L$
(B) $L_1 = \{0, 1\}^*$
(C) $L_1 \subseteq L$
(D) $L_1 = L$

[Gate 2003]

22. The following finite state machine accepts all those binary strings in which the number of 1's and 0's are respectively:



(A) Divisible by 3 and 2
(B) Odd and even
(C) Even and odd
(D) Divisible by 2 and 3

[Gate 2004]

23. Let $M = (K, \sum, \sigma, s, F)$ be a finite state automaton, where

$K = \{A, B\}, \sum = \{a, b\}, s = A, F = \{B\}$,

$\sigma(A, a) = A, \sigma(A, b) = B, \sigma(B, a) = B$ and $\sigma(B, b) = A$

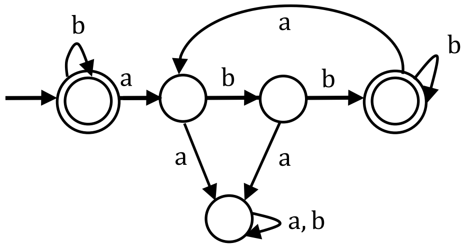
A grammar to generate the languages accepted by M can be specified as $G = (V, \sum, R, S)$, where $V = K \cup \sum$, and $S = A$.

Which one of the following set of rules will make $L(G) = L(M)$?

(A) { A $\rightarrow$ aB, A $\rightarrow$ bA, B $\rightarrow$ bA, B $\rightarrow$ aA, B $\rightarrow$ ϵ)
(B) { A $\rightarrow$ aA, A $\rightarrow$ bB, B $\rightarrow$ aB, B $\rightarrow$ bA, B $\rightarrow$ ϵ)
(C) { A $\rightarrow$ bB, A $\rightarrow$ aB, B $\rightarrow$ aA, B $\rightarrow$ bA, B $\rightarrow$ ϵ)
(D) { A $\rightarrow$ aA, A $\rightarrow$ bA, B $\rightarrow$ aB, B $\rightarrow$ bA, A $\rightarrow$ ϵ)

[Gate 2004]

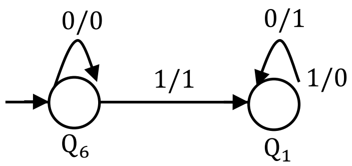
24. Consider the machine M:



The language recognized by M is:
(A) $\{\omega \in \{a, b\}^* \mid$ every a in ω is followed by exactly two b's$\}$
(B) $\{\omega \in \{a, b\}^* \mid$ every a in ω is followed by atleast two b's$\}$
(C) $\{\omega \in \{a, b\}^* \mid$ ω contains the substring 'abb'$\}$
(D) $\{\omega \in \{a, b\}^* \mid$ ω does not contain 'aa' as a substring$\}$

[Gate 2005]

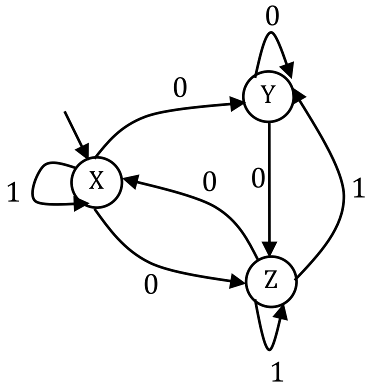
25. The following diagram represents a finite state machine which takes as input a binary number from the least significant bit.



Which of the following is TRUE?
(A) It computes 1's complement of the input number
(B) It computes 2's complement of the input number
(C) It increments the input number
(D) It decrements the input number

[Gate 2005]

26. Consider the non-deterministic finite automaton (NFA) shown in the figure.
State X is the starting state of the automaton. Let the language accepted by the NFA with Y as the only accepting state be L1. Similarly, let the language accepted by the NFA with Z as the only accepting state be L2. Which of the following statements about L1 and L2 is TRUE?



(A) L1 = L2
(B) L1 $\subset$ L2
(C) L2 $\subset$ L1
(D) None of the above

[Gate 2005]

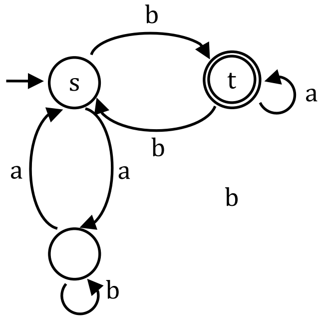
27. Consider the regular grammar:
$S \rightarrow Xa \mid Ya$
$X \rightarrow Za$
$Z \rightarrow Sa \mid \epsilon$
$Y \rightarrow Wa$
$W \rightarrow Sa$
Where S is the starting symbol, the set of terminals is {a} and the set of non-terminals is { S, W, X, Y, Z}.
We wish to constructs a deterministic finite automaton (DFA) to recognize the same language. What is the minimum number of states required for the DFA?
(A) 2
(B) 3
(C) 4
(D) 5

[Gate 2005]

28. Consider the regular language $L = (1\,1\,1 + 1\,1\,1\,1\,1)^*$. The minimum number of states in any DFA accepting this languages is :
(A) 3
(B) 5
(C) 8
(D) 9

[Gate 2006]

29. In the automaton below, s is the start state and t is the only final state.

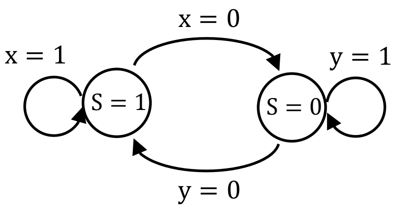


Consider the string u = abbaba, v = bab, and w = aabb. Which of the following statements is true?

(A) The automaton accepts u and v but not w
(B) The automaton accepts each of u, v, and w
(C) The automaton rejects each of u, v, and w
(D) The automaton accepts u but rejects v and w

[Gate 2006]

30. For a state machine with the following state diagram the expression for the next state S^+ in terms of the current state S and the input variables x and y is



(A) $S^+ = S'.y' + S.x$
(B) $S^+ = S.x.y' + S'.y.x'$
(C) $S^+ = x.y'$
(D) $S^+ = S'.y + S.x'$

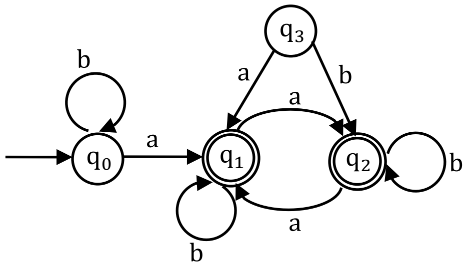
[Gate 2006]

31. A minimum state deterministic finite automaton accepting the language
$L = \{w | w \in |\{0,1\}^*$, number of 0's and 1's in w are divisible by 3 and 5, respectively} has

(A) 15 states
(B) 11 states
(C) 10 states
(D) 9 states

[Gate 2007]

32. Consider the following Finite State Automaton:



The languages accepted by this automaton is given by the regular expression

(A) $b^* ab^* ab^* ab^*$

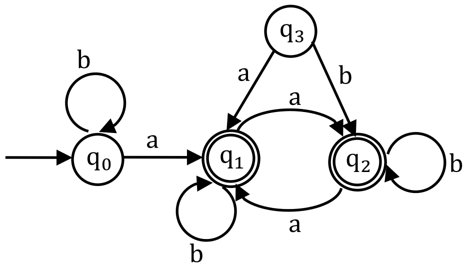
(B) $(a + b)^*$

(C) $b^* a(a + b)^*$

(D) $b^* ab^* ab^*$

[Gate 2007]

33. Consider the following Finite State Automaton:



The minimum state automaton equivalent to the above FSA has the following number of states:

(A) 1

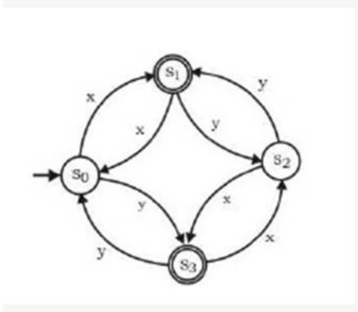
(B) 2

(C) 3

(D) 4

[Gate 2007]

34. Consider the following DFA in which S_0 is the start state and S_1, S_3 are the final states.



What language does this DFA recognize?

(A) All strings of x and y

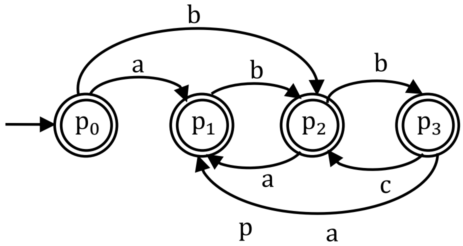
(B) All strings of x and y which have either even number of x and even number of y or odd number of x and odd number of y

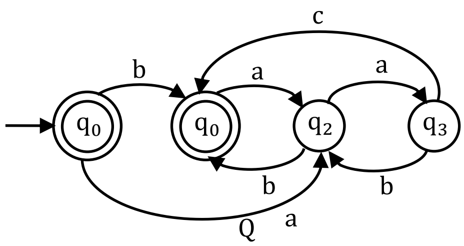
(C) All strings of x and y which have equal number of x and y

(D) All strings of x and y with either even number of x and odd number of y or odd number of x and even number of y

[Gate 2007]

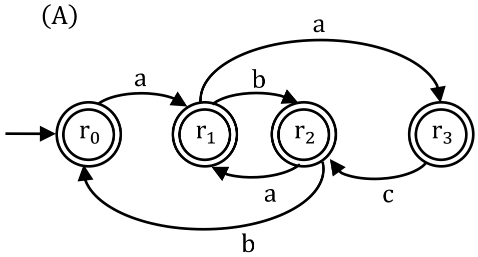
35. Consider the following finite automata P and Q over the alphabet { a, b, c}. The set states are indicated by a double arrow and final states are indicated by a double circle. Let the languages recognized by them be denoted by L (P) and L(Q) respectively.



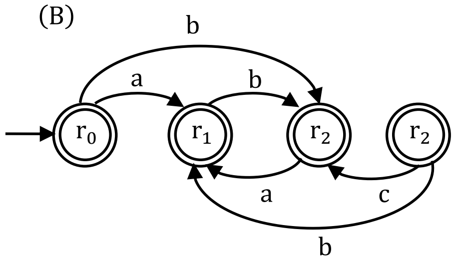


The automation which recognizes the languages L(P) ∩ L(Q) is:

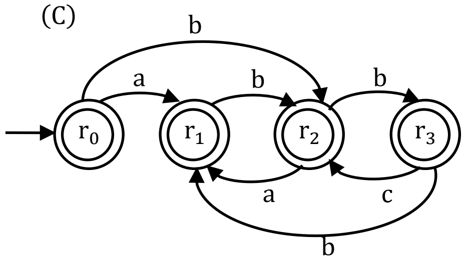
(A)



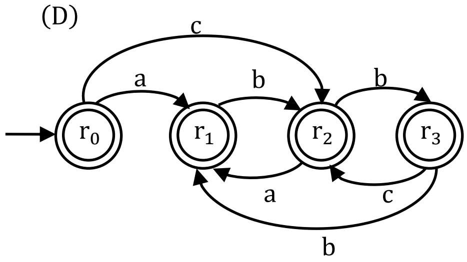
(B)



(C)



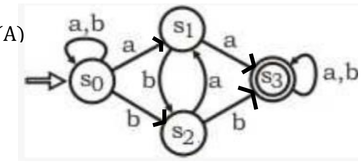
(D)



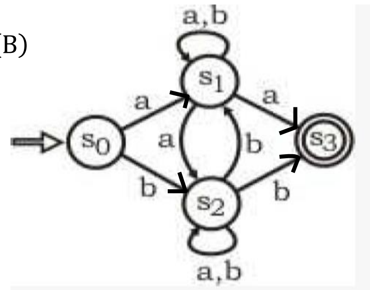
[Gate 2007]

36. Consider the regular expression $R = (a + b)^* (aa + bb) (a + b)^*$
Which of the following non-deterministic finite automata recognizes the language defined by the regular expression R? Edges labelled ⋋ denote transitions on the empty string.

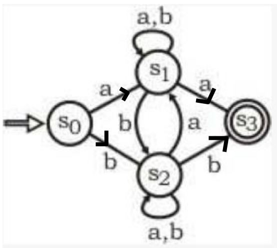
(A)



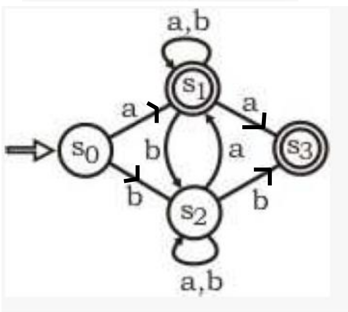
(B)



(C)



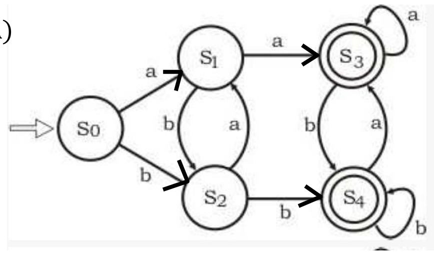
(D)



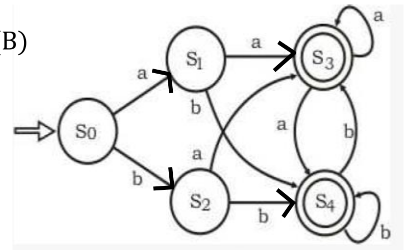
[Gate 2007-IT]

37. Consider the regular expression $R = (a + b)^* (aa + bb) (a + b)^*$
Which deterministic finite automaton accepts the language represented by the regular expression R?

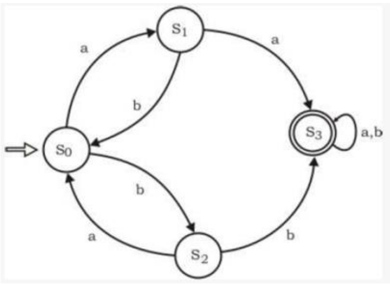
(A)



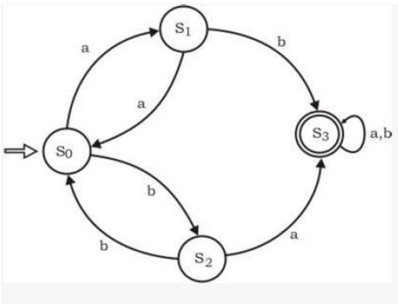
(B)



(C)



(D)



[Gate 2007]

38. Given below are two finite state automata(→ indicates the start state and F indicates a final state)

Y

	a	b
→ 1	1	2
2(F)	2	1

Z

	a	b
→ 1	2	2
2 (F)	1	1

Which of the following represents the product automaton Z × Y?

(A)

	a	b
→P	S	R
Q	R	S
R(F)	Q	P
S	Q	P

(B)

	a	b
→ P	S	Q
Q	R	S
R(F)	Q	P
S	P	Q

(C)

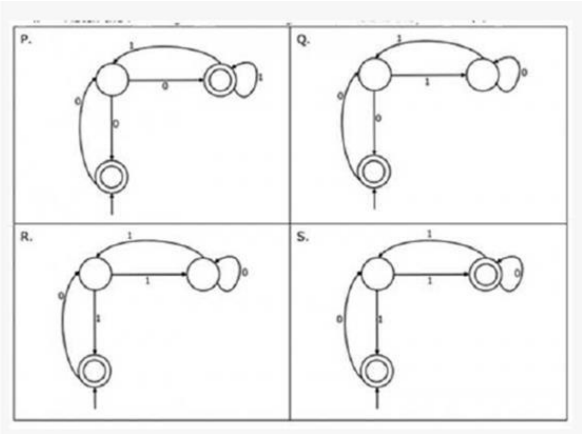
	a	b
→ P	Q	S
Q	R	S
R (F)	Q	P
S	Q	P

(D)

	a	b
→ P	S	Q
Q	S	R
R(F)	Q	P
S	Q	P

[Gate 2008]

39. Match the following NFAs with the regular expressions they correspond to:

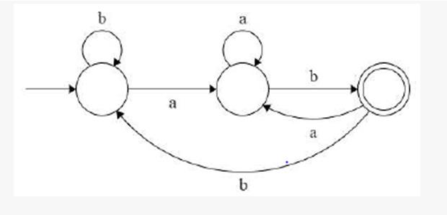


1. $\in +0(01^*1 + 00)^*\, 01^*$
2. $\in +0\,(10^*1 + 00)^*\, 0$
3. $\in +0\,(10^*\,1 + 10)^*1$
4. $\in +0(10^*1 + 10)^*\, 10^*$

(A) P − 2, Q − 1, R − 3, S − 4
(B) P − 1, Q − 3, R − 2, S − 4
(C) P − 1, Q − 2, R − 3, S − 4
(D) P − 3, Q − 2, R − 1, S − 4

[Gate 2008]

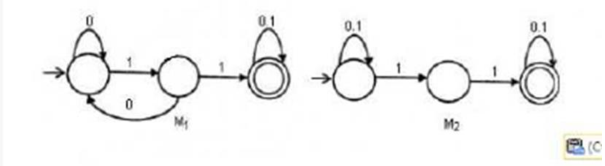
40. If the final states and non-final states in the DFA below are interchanged, then which of the following languages over the alphabet {a, b} will be accepted by the new DFA?



(A) Set of all strings that do not end with ab
(B) Set of all strings that begin with either an a or a b
(C) Set of all strings that do not contain the substring ab,
(D) The set described by the regular expression $b^* aa^* (ba)^* b^*$

[Gate 2008]

41. Consider the following two finite automata. M_1 accepts L_1 and M_2 accepts L_2.



(A) $L_1 = L_2$
(B) $L_1 \subset L_2$
(C) $L_1 \cap L_{2'} = \emptyset$
(D) $L_1 \cup L_2 \neq L_1$

[Gate 2008]

42. Let N be an NFA with n states and let M be the minimized DFA with m states recognizing the same language. Which of the following in NECESSARILY true?
(A) $m \leq 2^n$
(B) $n \leq m$
(C) M has one accept state
(D) $m = 2^n$

[Gate 2008]

43. Given the following state table of an FSM with two states A and B , one input and one output.

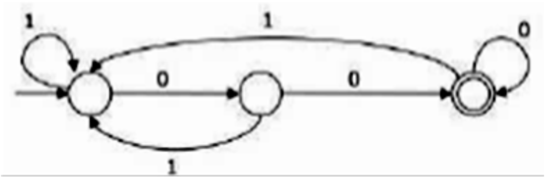
PRESENT STATE A	PRESENT STATE B	Input	Next State A	Next State B	Output
0	0	0	0	0	1
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	1	0	0
0	0	1	0	1	0
0	1	1	0	0	1
1	0	1	0	1	1
1	1	1	0	0	1

If the initial state is $A = 0, B = 0$ what is the minimum length of an input string which will take the machine to the state $A = 0, B = 1$ with output=1.

(A) 3
(B) 4
(C) 5
(D) 6

[Gate 2009]

44. The below DFA accepts the set of all strings over {0,1 } that



(A) Begin either with 0 or 1
(B) End with 0.
(C) End with 00.
(D) Contain the substring 00.

[Gate 2009]

45. Let w be any string of length n in $\{0, 1\}^*$. Let L be the set of all substrings of w. what is the minimum number of states in non-deterministic finite automation that accepts L?

(A) $n - 1$
(B) n
(C) $n + 1$
(D) 2^{n-1}

[Gate 2010]

46. Definition of a language L with alphabet {a} is given as following.

$L = \{ a^{nk} | k > 0, \text{and n is a positive integer constant}\}$

What is the minimum number of states needed in a DFA to recognize L?

(A) $k + 1$

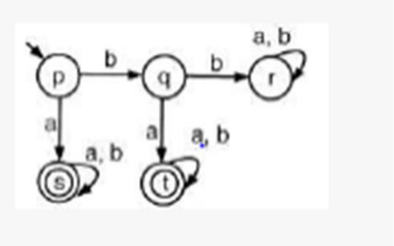
(B) $n + 1$

(C) 2^{n+1}

(D) 2^{k+1}

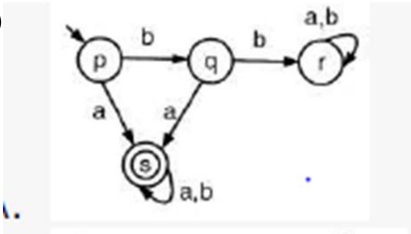
[Gate 2011]

47. A deterministic finite automaton (DFA) D with alphabet $\sum = \{a, b\}$ is given below.

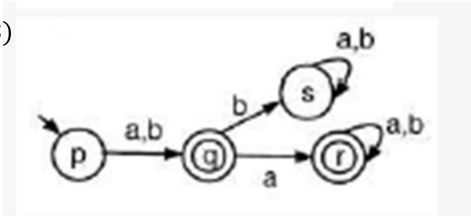


Which of the following finite state machines is a valid minimal DFA which accepts the same languages as D?

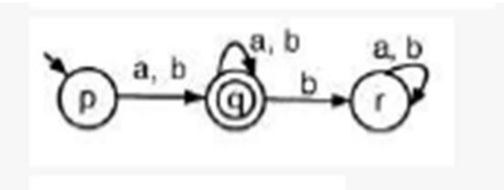
(A)

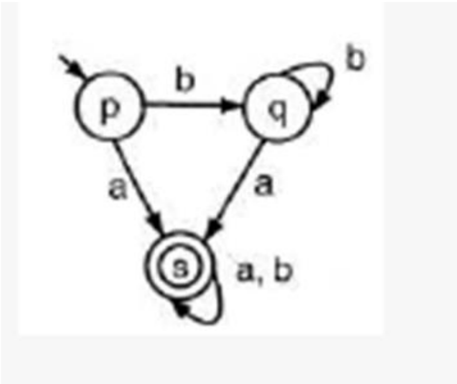


(B)



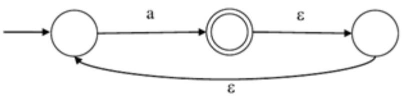
(C)



(D)


[Gate 2011]

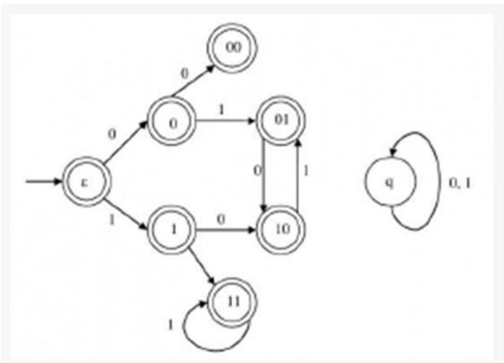
48. What is the complement of the language accepted by the NFA shown below?
Assume $\sum = \{a\}$ and ϵ is the empty string.



(A) $\emptyset$
(B) $\{\epsilon\}$
(C) a^*
(D) $\{a, \epsilon\}$

[Gate 2012]

49. Consider the set of strings on {0, 1} in which, every substring of 3 symbols has at most two zeros. For example, 001110 and 011001 are in the language, but 100010 is not. All strings of length less than 3 are also in the language. A partially completed DFA that accepts this language is shown below.



The missing arcs in the DFA are:

A.

	00	01	10	11	q
00	1	0			
01				1	
10	0				
11			0		

B.

	00	01	10	11	q
00		0			1
01		1			
10				0	
11		0			

C.

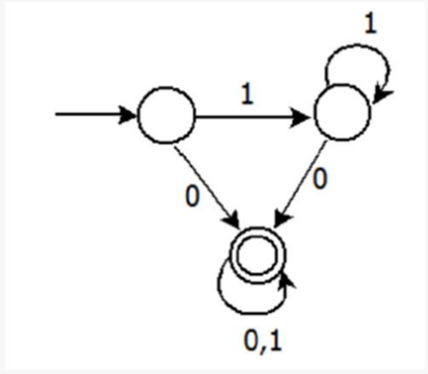
	00	01	10	11	q
00		1			0
01		1			
10			0		
11		0			

D.

	00	01	10	11	q
00		1			0
01				1	
10	0				
11			0		

[Gate 2012]

50. Consider the DFA A given below.



Which of the following are FALSE?

(1) Complement of L(A) is context-free.

(2) $L(A) = L((11^*0 + 0)(0 + 1)^* 0^* 1^*)$

(3) For the language accepted by A, A is the minimal DFA.

(4) A accepts all strings over {0, 1} of length at least 2.

(A) 1 and 3 only

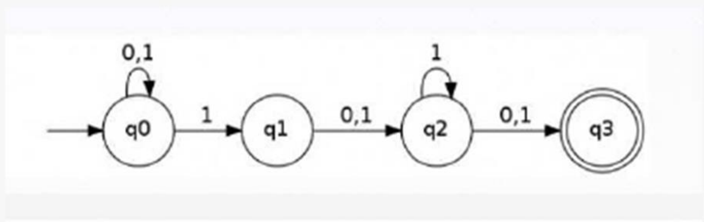
(B) 2 and 4 only

(C) 2 and 3 only

(D) 3 and 4 only

[Gate 2013]

51. Consider the finite automaton in the following figure:



What is the set of reachable states for the input string 0011?

(A) $\{ q_0, q_1, q_2\}$

(B) $\{q_0, q_1\}$

(C) $\{q_0, q_1, q_2, q_3\}$

(D) $\{q_3 \}$

[Gate 2014]

52. Consider the DFAs M and N given below. The number of states in a minimal DFA that accept the language $L(M) \cap L(N)$ is __________.

[Gate 2015]

53. The number of states in the minimal deterministic finite automaton corresponding to the regular expression $(0+1)^*$ (10) is ________.

[Gate 2015]

54. Let L be the language represented by the regular expression $\sum^*$ $0011\sum^*$ where $\sum = \{0, 1\}$. what is the minimum number of states in a DFA that recognizes L(complement of $L4)?
(A) 4
(B) 5
(C) 6
(D) 8

[Gate 2015]

55. The number of states in the minimum sized DFA that accepts the language defined by the regular expression.
$(0+1)^*(0+1)(0+1)^*$
is ___________.

[Gate 2016]

56. Consider the following two statements:
I. If all states of an NFA are accepting states then the language accepted by the NFA is $\sum^*$
II. There exists a regular language A such that for all languages B, A $\cap$ B is regular.
Which one of the following is CORRECT?
(A) Only I is true
(B) Only II is true
(C) Both I and II are true
(D) Both I and II are false

[Gate 2016]

57. Consider the language L given by the regular expression $(a+b)^*\, b(a+b)$ over the alphabet {a, b}. The smallest number of states needed in a deterministic finite-state automaton (DFA) accepting L is ___________

[Gate 2017]

58. The minimum possible number of states of a deterministic finite automaton that accepts the regular language $L = \{ w_1\, aw_2 \mid w_1, w_2 \in \{a, b\}^*, |w_1| = 2, |w_2| \geq 3 \}$ is _________

[Gate 2017]

59. Let δ denote the transition function and $\hat{\delta}$ denote the extended transition function of the ϵ − NFA whose transition table is given below:

δ	ϵ	a	b
$\rightarrow q_0$	$\{q_2\}$	$\{q_1\}$	$\{q_0\}$
q_1	$\{q_2\}$	$\{q_2\}$	$\{q_3\}$
$\{q_2\}$	$\{q_0\}$	$\emptyset$	$\emptyset$
q_3	$\emptyset$	$\emptyset$	$\{q_2\}$

Then $\hat{\delta}(q_2, aba)$ is

(A) $\emptyset$

(B) $\{q_0, q_1, q_3\}$

(C) $\{q_0, q_1, q_2\}$

(D) $\{q_0, q_2, q_3\}$

[Gate 2017]