Section – A

Attempt all questions. **[3 x 2 = 6 Marks]**

Q1. Construct a Moore machine that takes binary numbers as input and produces residue modulo '3' as output.

Q2. Construct and verify a FA that accepts all the decimal strings divisible by 4.

Q3. Write the statement of Pumping Lemma for Regular sets with at least one application.

Section – B

Attempt all questions **[3 x 3 = 9 Marks]**

Q1. Construct a FA in such that accepts the strings having no. of 'a' divisible by 3 and no. of 'b' divisible by 2 i.e.

$$n_a(w) \cong 0 \bmod 3, \quad \& \quad n_b(w) \cong 0 \bmod 2, \text{ where } w \in (a,b)^*$$

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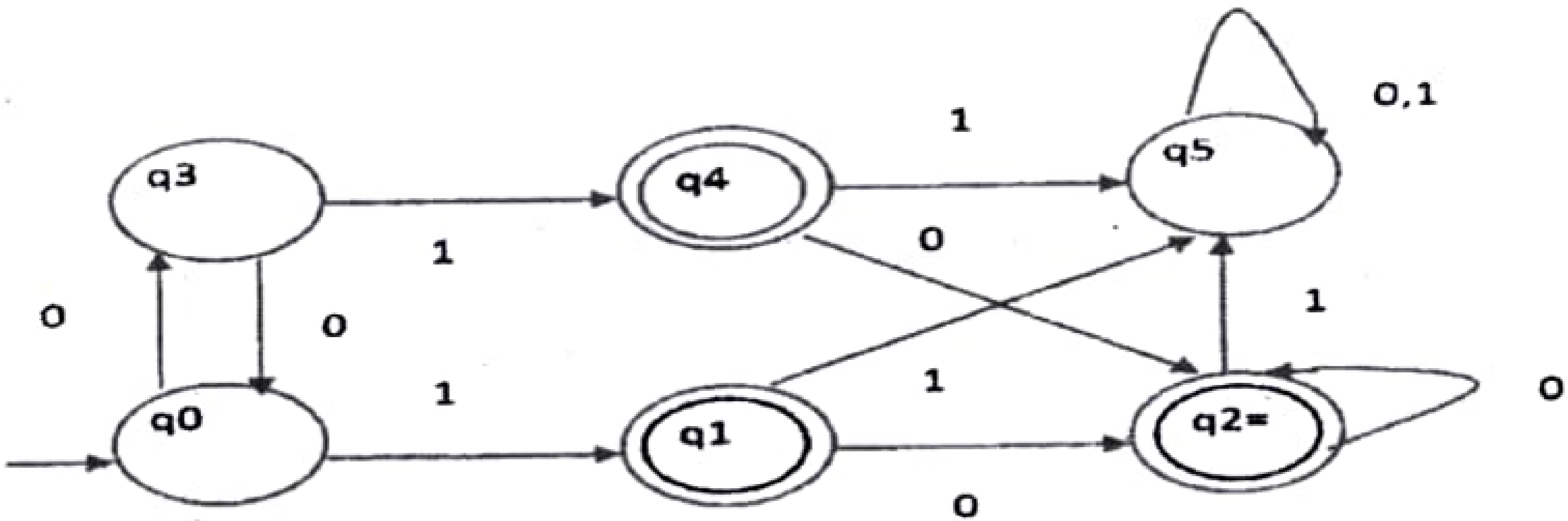
$$n_a(w) \cong 0 \bmod 3, \quad \& \quad n_b(w) \cong 0 \bmod 2, \text{ where } w \in (a,b)^*$$

Q2. Construct a DFA equivalent to the given regular expression as:

ab+(a+bb)a*b

Q3. Minimize the given FA in step by step manner:



Attempt All Three Questi[redacted] **[3 x 2 = 6]**

1. Draw a deterministic finite automaton (DFA) that recognizes the language over the alphabet {0, 1} consisting of all those strings that contain an odd number of 1's.

2. Find all strings in L ((a + b)*b(a + ab)*) of length <u>less than four</u>.

3. Draw a NFA for the language $L = \{ w \in \Sigma^* \mid w$ contains the substring 0101, i.e., $w = x0101y$ for some $x, y \in \Sigma^* \}$

<u>Section- B</u>

<u>**Attempt All Three Questions.**</u> **[3 x 3 = 9]**

4. Construct a DFA for the set of strings over {a, b} containing **both ab and ba** as substrings.

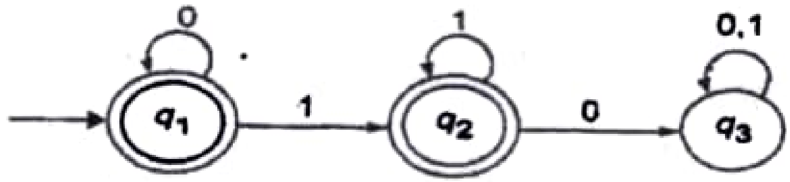
5. Construct a **Moore machine** that takes binary numbers as input and produces residue modulo '3' as output.

6. Let Σ = {a, b}. For each of the following languages over Σ find a RE representing it.
   a. All string that contain exactly one b
   b. $L = \{w \mid w$ contains at least three consecutive 1s$\}$
   c. All strings that contain either sub-string *aaa* or *bbb*.

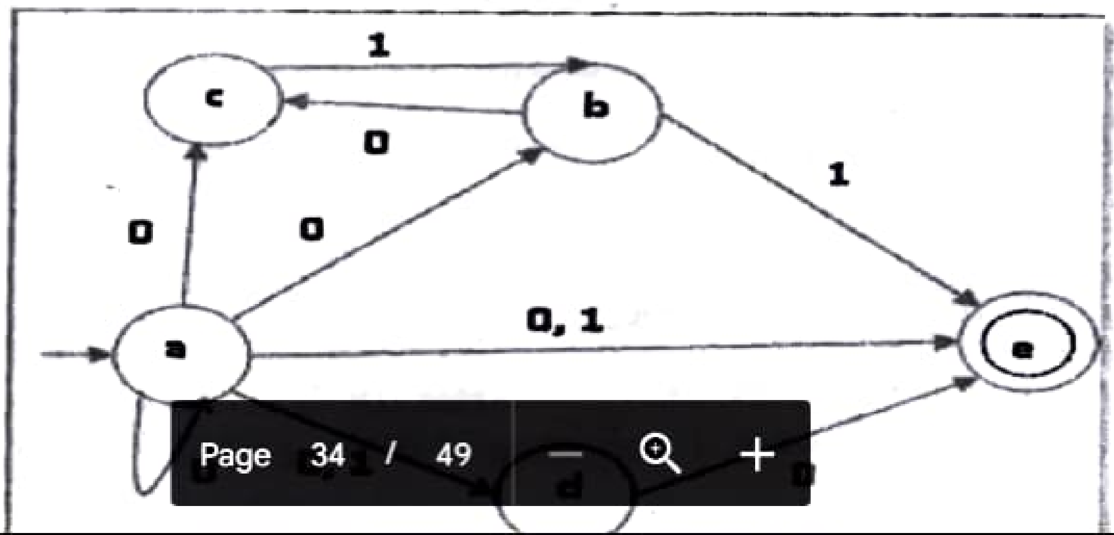
<u>Section – C</u>

<u>Note: Attempt Any Three Questions.</u> **[3 x 5 = 15]**

7. **Apply Arden's theorem to find the Regular Expression corresponding to the following FA**



8. Convert the following Non Deterministic Finite Automaton into an equivalent deterministic automaton M. Clearly mention all the 5 tuples of M and draw the complete transition graph.



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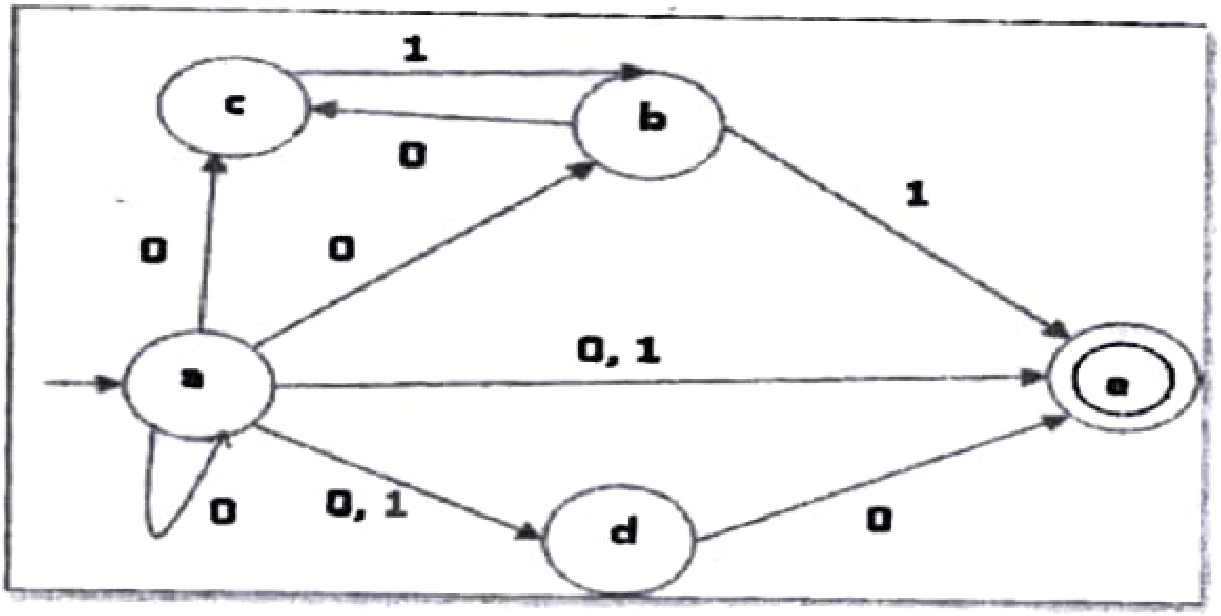

9. Minimize the DFA whose transition table is given below. Draw the transition graph for the minimized DFA.

Present State	Next State	
	a	b
→q0	q1	q5
q1	q6	q2
q2 (Final state)	q0	q2
q3	q2	q6
q4	q7	q5
q5	q2	q6
q6	q6	q4
q7	q6	q2

9. Minimize the DFA whose transition table is given below. Draw the transition graph for the minimized DFA.

Present State	Next State	
	a	b
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q3	q2	q6
q4	q7	q5
q5	q2	q6
q6	q6	q4
q7	q6	q2

10. Attempt both of the following. [2.5 + 2.5 = 5]

a. Consider a language over the alphabet {0, 1} consisting of the strings that meet the following conditions:

- The length of the strings is 6.
- The last two characters must both be zero. For example, 110000, 001100, and 111100 are all in the language; 000011, 001010, and 111001 are not.

Write a regular expression that defines this language.

b. Construct a DFA equivalent to the regular expression **a* (ba*)*.**
Note: Directly draw the DFA.

Section A

Note: Attempt All Questions (1x5=5)

I. Write the regular expression for L= $\{a^i b^j$, i is multiple of 3 and j is multiple of 2$\}$.

II. How many final states will be there in a DFA which accept strings containing exactly two 0's or exactly two 1's?

III. State Pumping Lemma for regular languages.

IV. Design a NFA which accept L = {ab, ba}.

V. Write two strings which are not the member of L = {a, ab, abb, bab}*.

Section B

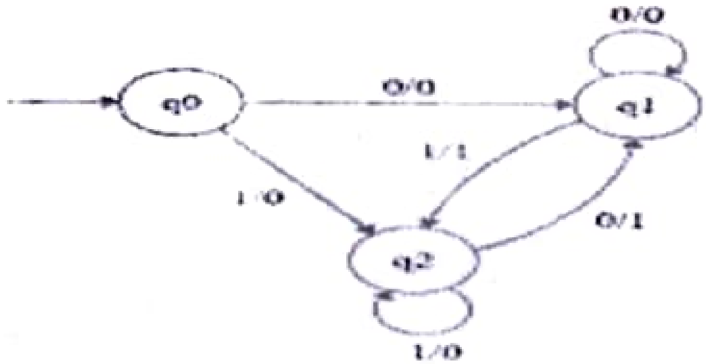
Note: Attempt any Three Questions (2x3=6)

I. Construct an equivalent DFA for the given NFA:

State/Input	a	b
→q1	q2, q3	q1
q2	q1, q2	q1, q2
q3*	q2	q1, q2

q2	q1, q2	q1, q2
q3*	q2	q1, q2

II. Convert the given Mealy machine to equivalent Moore machine:



III. Design a DFA which accept all strings ending with 'aab' over $\Sigma = \{a, b\}$.

IV. Construct finite automata for the regular expression **abb+a(a+b)*ba**

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Section C

Note: Attempt any Three Questions (3x3=9)

I. Construct a DFA which accepts all binary integers divisible by 2 and 3.

II. Construct a minimum-state automata for given DFA:

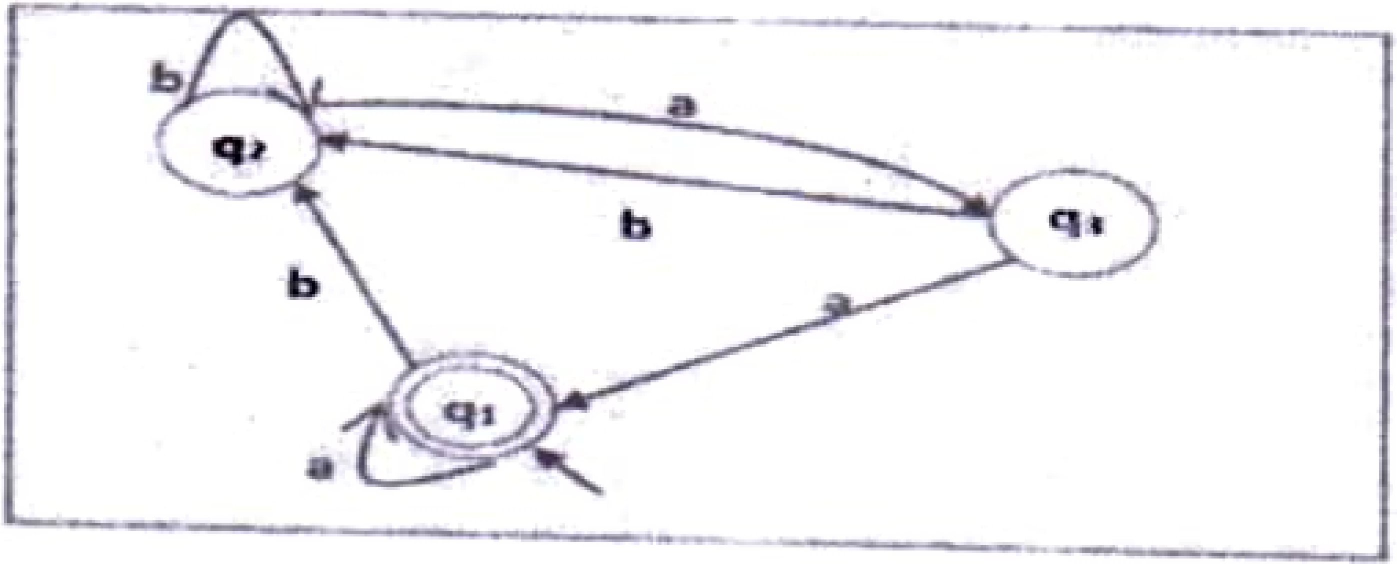
State/Input	0	1
→A	B	A
B	A	C
C	D	B
D*	D	A
E	D	F
F	G	E
G	F	G
H	G	D

III. State and prove Arden's theorem for regular expressions.

IV. Obtain regular expression for given finite automata using algebraic method:

III. State and prove Arden's theorem for regular expressions.

IV. Obtain regular expression for given finite automata using algebraic method:



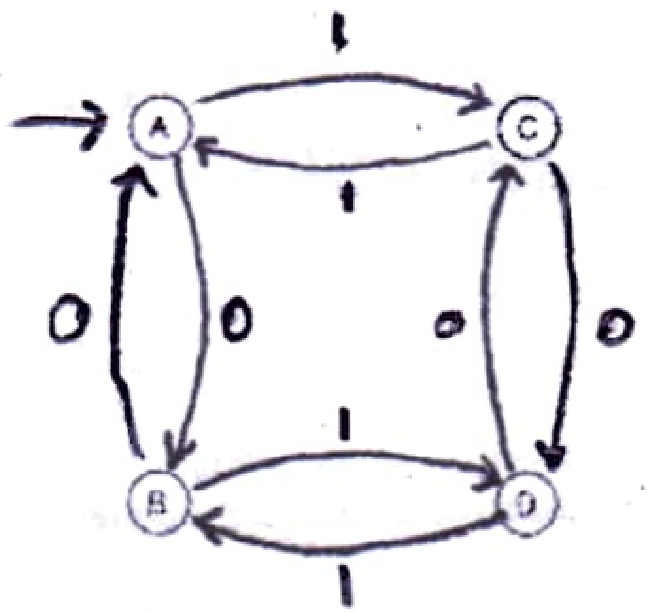
A.I Consider the following statements. Write the false statement(s) in your answer book.

- The number of outgoing arcs from a state of a DFA is always equal to $|\Sigma|$.
- Not all finite languages are regular.
- The family of regular languages is closed under intersection.
- The number of outgoing arcs from a state of a NFA is always equal to $|\Sigma|$.

A.II Which of the following strings are matched by the regular expression aa*bb*b + (bb+aa)*

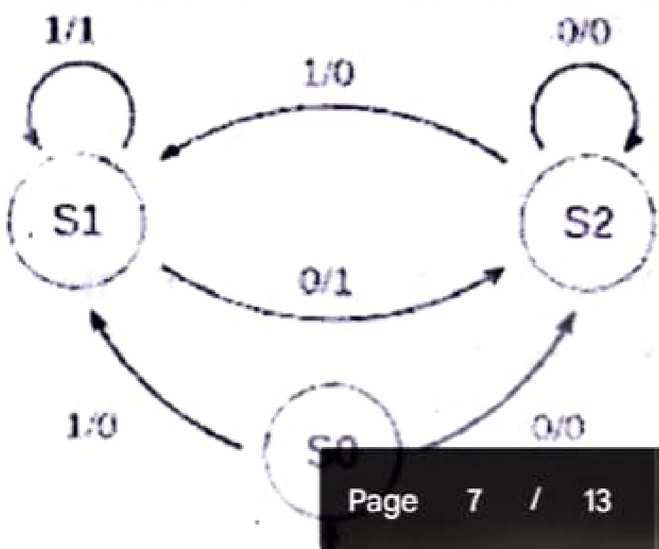
- aaa
- aaaa
- aabb
- bbaab

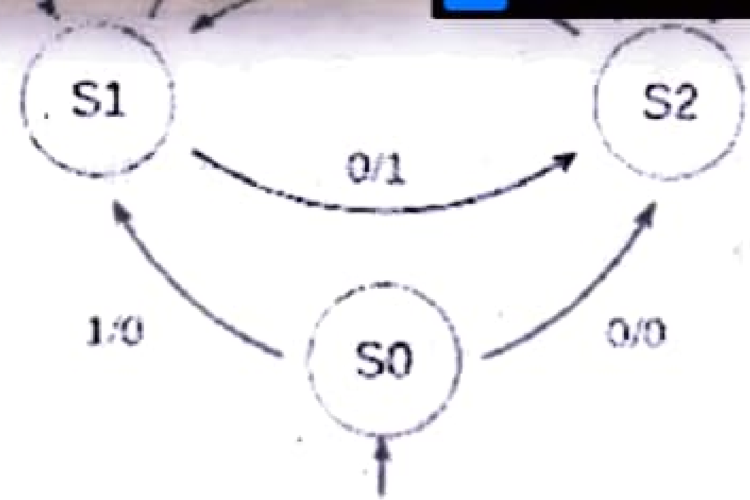
A.III Consider the following finite automaton over the alphabet {0, 1}. Which states should be made accepting in order for this automaton to accept the language of strings with odd length?



A.IV What are the applications of Finite Automata?

A.V What type of machine does the following represent? Why?





Section B

Note: Attempt any Three Questions [2x3=6]

B.I Give a DFA for the following language, specified by a transition diagram, where $\Sigma = \{0, 1, 2\}$.
$L = (w \in \Sigma^* \mid$ w begins with 0 or ends with 0 but not both}

B.II Show that the family of regular languages is closed under difference $(L_1 - L_2)$.

B.III What language is represented by the regular expression (((a*a)b)Ub)?

B.IV Design an NFA with three states that accepts the language {ab, abc}*.

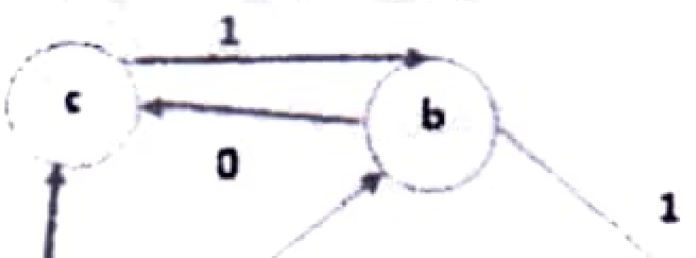
Section C

Note: Attempt any Three Questions [3x3=9]

C.I Prove that the following language is not regular using Pumping Lemma.

$$L = \{a^n b^l c^k \mid k \geq n + l\}$$

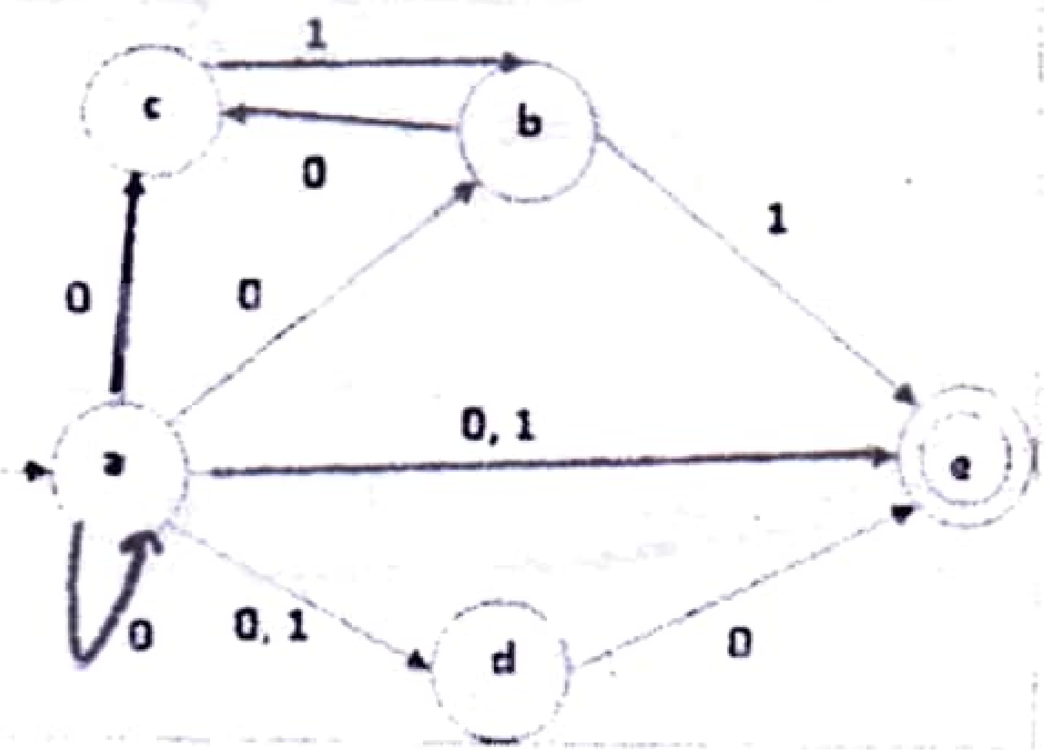
C.II Convert the following NFA to an equivalent DFA.



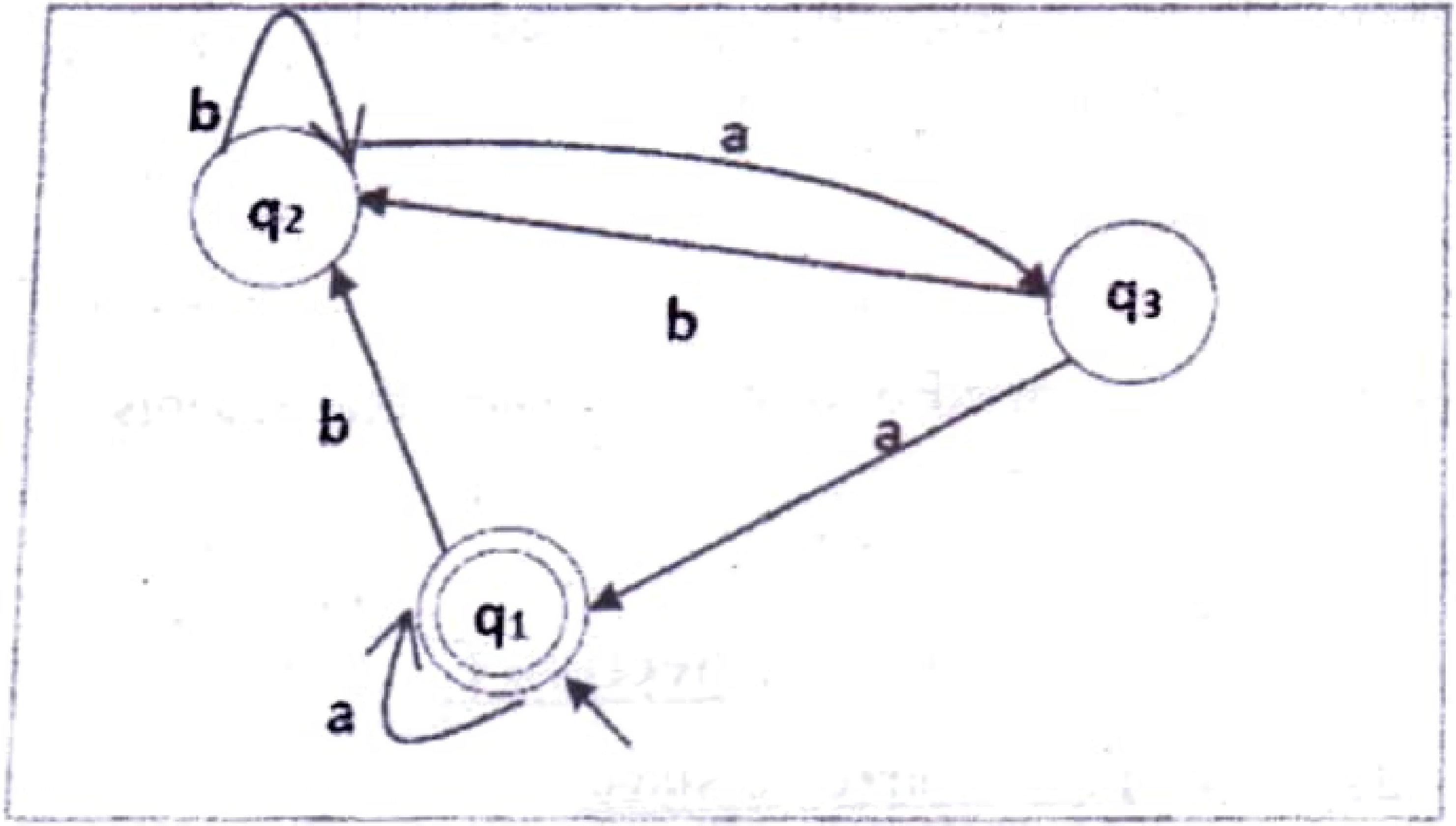
Pumping Lemma.

$$L = \{a^n b^l c^k \mid k \geq n + l\}$$

C.II Convert the following NFA to an equivalent DFA.



C.III Use Arden's Theorem to construct a regular expression corresponding to the automata given below.



b
a
q2
b
q3
b
a
q1
a

C.IV Minimize the following DFA.