PES University, Bangalore

(Established under Karnataka Act No. 16 of 2013) **UE19CS205**

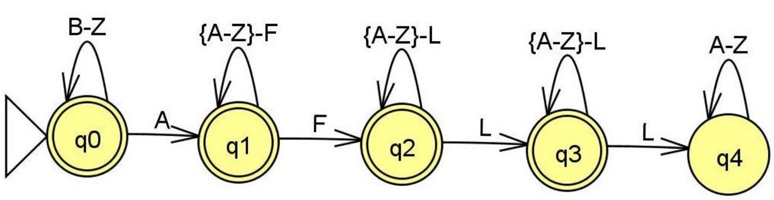
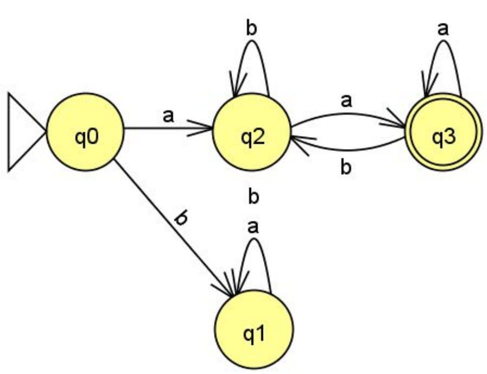
SAMPLE PAPER-III SOLUTION FOR

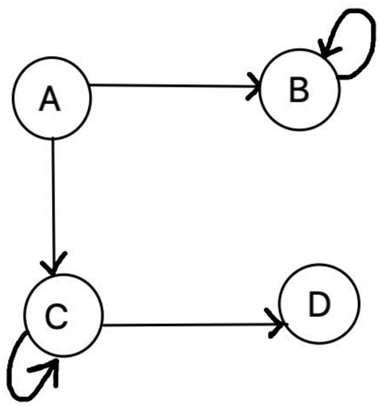
IN SEMESTER ASSESSMENT (ISA-1)- B.TECH III SEMESTER

October, 2020

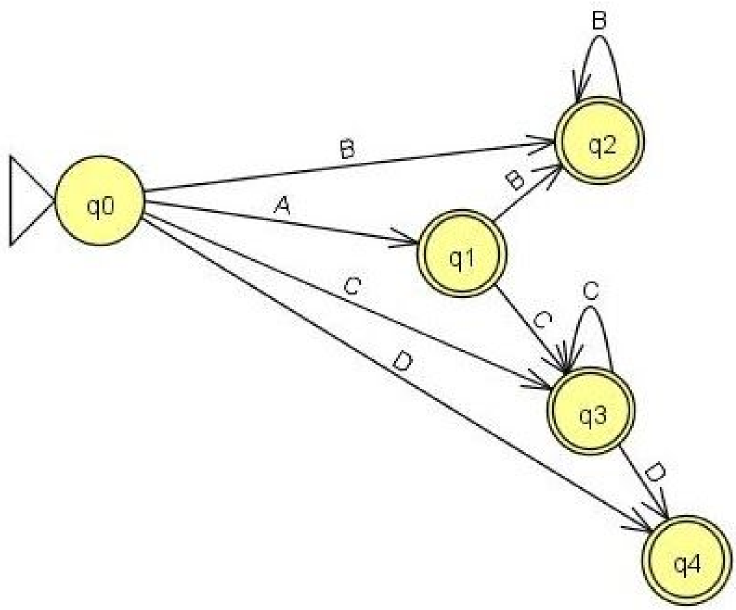
Automata Formal Languages & Logic

Time: 2 Hrs **Answer All Questions** **Max Marks: 60**

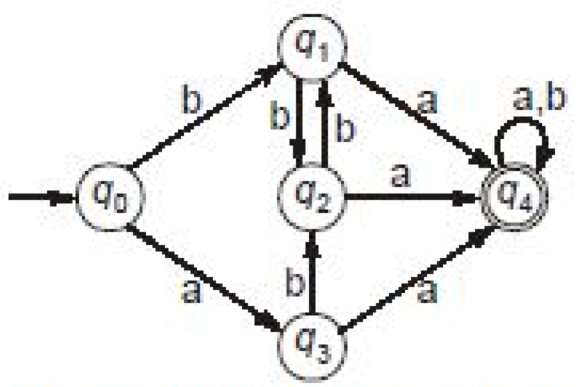
1	a	Suppose that you really, really dislike the string AFLL and want to build a language for everything except that string. Let Σ = {A, B, C, D ….. Z} and consider the language $L_{\sim AFLL}$ defined as follows: $L_{\sim AFLL} = \{ w \in \Sigma^* \mid w \neq AFLL \}$ For example, $\lambda \in L_{\sim AFLL}$, any other string like HELLO $\in L_{\sim AFLL}$, FLYR $\in L_{\sim AFLL}$ etc., but AFLL $\notin L_{\sim AFLL}$ Design a DFA for the language $L_{\sim AFLL}$ **Solution:**  	6
	b	Describe the language (i.e., set of all strings) accepted by the following automaton:  Solution: The language accepted by the given automata is starting with a and ending with a and minimum string is aa.	4

2	a	Let $\Sigma = \{1, 2, 3\}$. A path in a graph is a series of nodes $v_1, v_2, \ldots, v_n$ such that each pair of adjacent nodes in the path is connected by an edge.  We can represent a path in Graph as a nonempty string where the letters spell out the path in the graph. For example, the path A, C, C, D would be represented by the string ACCD. Let $L = \{ w \in \Sigma^* \mid w$ represents a path in G $\}$, where G is the graph given above. For example: $A \in L$, $B \in L$, $C \in L$, $D \in L$ $AB \in L$, $ABB \in L$, $ABBBBB \in L$, etc $BBBBB \in L$ $CCCC \in L$, $CCD \in L$ $ACCD \in L$ $\varepsilon \notin L$ $BBAC \notin L$ $ABBC \notin L$, $ADC \notin L$, $DAC \notin L$ Design a Finite Acceptor for the above Language L.	6

Solution:



b Minimize the following DFA: 4



Solution:

Table filling method .

q1				
q2				
q3				
***q4**				
	q0	**q1**	**q2**	**q3**

Mark the distinguishable and indistinguishable pairs.

Distinguishable: (final,non-final) pair

Indistinguishable: (final,final) pair(,non-final,non-final) pair

Since q4 is the final state ,pairs(q0,q4)(q1,q4)(q2,q4)(q3,q4) will be marked as distinguishable pairs.

Next,

- (q0,q1) on a (q3,q4) (q0,q1) on b (q1,q2)

Since (q3,q4) is marked as distinguishable we will mark (q0,q1) as distinguishable.

- (q0,q2) on a (q3,q4) (q0,q2) on b (q1,q1)

Since (q3,q4) is marked as distinguishable we will mark (q0,q2) as distinguishable.

- (q0,q3) on a (q3,q4) (q0,q3) on b (q1,q2)

Since (q3,q4) is marked as distinguishable we will mark (q0,q3) as distinguishable.

- (q1,q2) on a (q4,q4) (q1,q2) on b (q2,q1)

As (q4,q4) is indistinguishable, we need to check (q2,q1) .

- (q2,q1) on a (q4,q4) (q2,q1) on b (q1,q2)

It appears that q1, q2 are indistinguishable .

Next ,

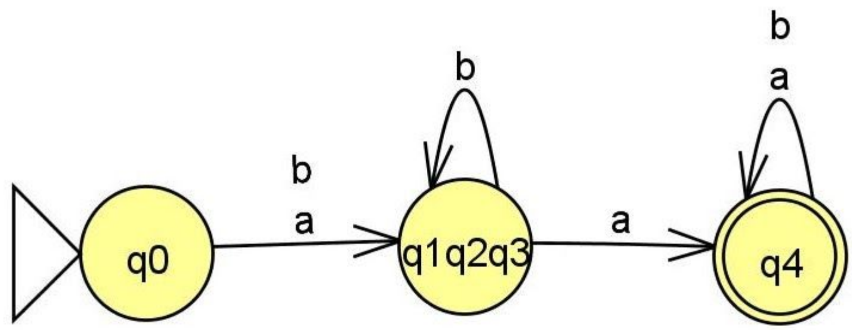
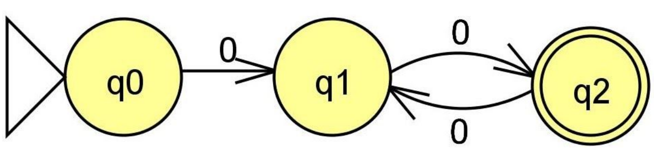
- (q1,q3) on a (q4,q4), (q1,q3) on b (q1,q2)

Since (q1,q2) is marked as indistinguishable,we will mark (q1,q3)as indistinguishable.

- (q2,q3) on a (q4,q4), (q1,q3) on b (q1,q2)

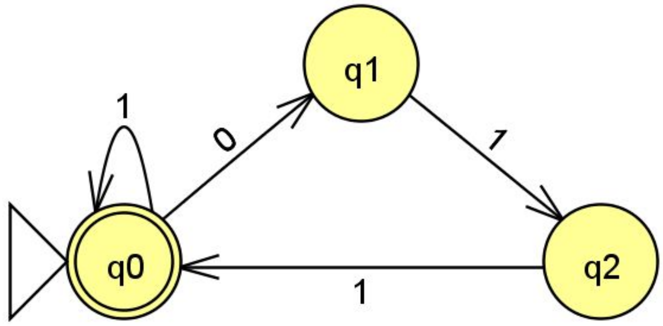
Since (q1,q2) is marked as indistinguishable,we will mark (q2,q3)as indistinguishable.

q1	X			
q2	X	✓		
q3	X	✓	✓	
*q4	X	X	X	X
	q0	q1	q2	q3

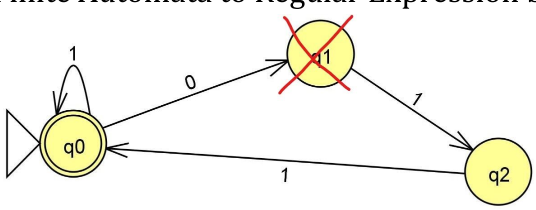
		From the table we see that we can merge q1,q2 and q2,q3 .Therefore,we can merge q1,q2,q3. 	
3	a	Does the following language satisfy the pumping property? L = $\{0^{2n} \mid n \geq 1\}$ Also specify whether or not the above language is regular. **Solution:** We can construct a DFA with three states for the given language, proving that the language is regular:  **Proving that the language L satisfies pumping property:** Pumping length =3 So, we pick up a string of length>=3 $xy^iz \in L$ for i=0,1,2…. |xy|<=n ,|y|>=1 For the string 0000 ,we can split it up into xy^iz ,$0(00)^i0$,for any value of i>=0 the string will always belong to the language. Hence proved that the language satisfies pumping property.	5
	b	Answer the following : 1. Are the following pairs of RegEx's equivalent? Justify $(0 + 1)^*(0 + \lambda)$ and $(1 + \lambda)(1 + 0)^*(0 + 1 + \lambda)$ **Solution:** Yes, Both the regular expression represent (0+1)*.	5 (2+3)

		2. Describe the language of the following grammar as concisely as possible: $S \rightarrow aA \mid \lambda$ $A \rightarrow bS$ **Solution:** (ab)*=sequences of ab including λ.	
4	a	Construct a regular grammar to generate a number which can optionally have a decimal in which case the precision is exactly 2. (We assume by default that the number is positive) *valid strings :* 123.12 2 56754 92929292929292.12 0.21 *Invalid strings:* 12.1232 2.23332 e666.76 12. 12.2 **Solution:** Regular Expression: [0-9]+(\.[0-9][0-9])? or \d+(\.\d[2])? **Regular Grammar:** S→ (0-9)A A→ .B| λ. B→ (0-9)C| λ. C→ (0-9)| λ.	5

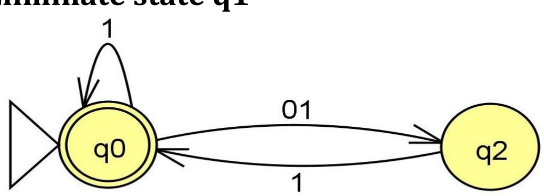
b Convert the following finite automata to regex: 5



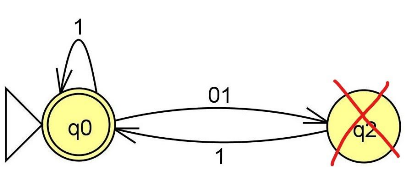
Solution:
Finite Automata to Regular Expression by state elimination method.

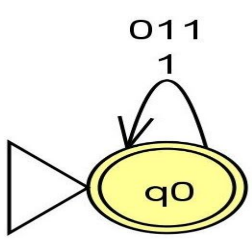


Eliminate state q1

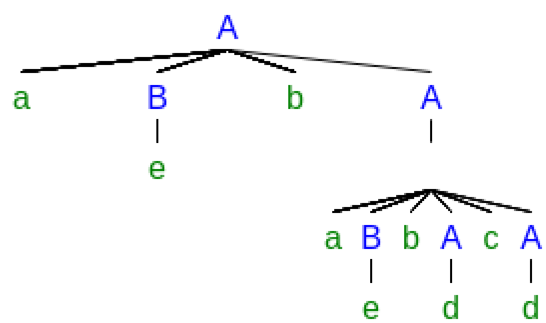
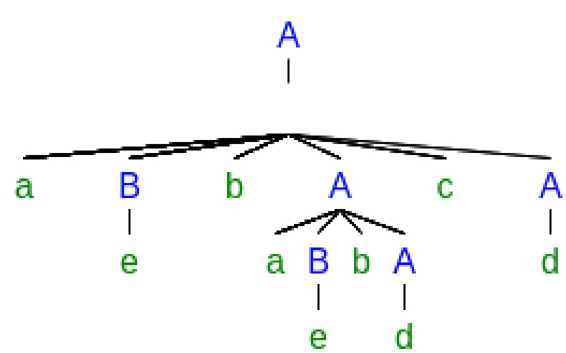


Eliminate state q2





Regular Expression for the given automata is (1+011)*

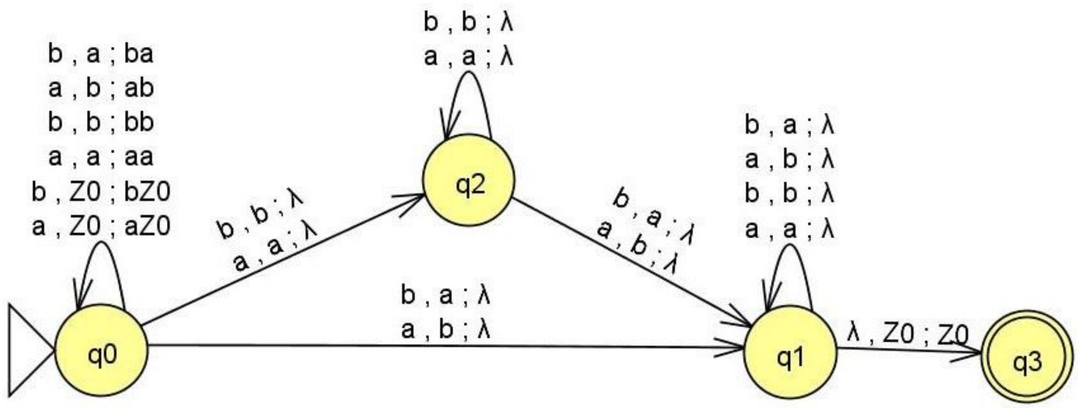
5	a	Is the following CFG ambiguous? If yes, show this. If no, explain why. A → aBbA | aBbAcA | d B → e A and B are nonterminals, A is the start symbol, a, b, c, d, and e are terminals. **Solution:** Yes, the grammar is ambiguous.Two different leftmost derivation for the string:aebaebdcd Leftmost Derivation 1: A⇒ aBbA ⇒ aebA ⇒ aebaBbAcA ⇒ aebaebAcA ⇒ aebaebdcA ⇒ aebaebdcd Parse Tree 1:  Leftmost Derivation 2: A⇒ aBbAcA ⇒aebAcA ⇒aebaBbAcA ⇒aebaebAcA ⇒aebaebdcA ⇒ aebaebdcd Parse Tree 2: 	5

<table>
<tr><td></td><td>b</td><td>

Show that L = {wx | w, x ∈ {a, b}∗ , |w| = |x|, and w != x}is a context free language.

Solution:

To prove a language is context free ,you can construct a PDA or a CFG.



Since we can construct a PDA for the given language ,we can conclude that the given language is context free.

</td><td>5</td></tr>
<tr><td>6</td><td>a</td><td>

Convert the following grammar to an equivalent one with no unit productions and no useless symbols. Show that the original grammar had NO useless symbols.
What useless symbols are there after getting rid of unit productions?

S → A | CB
A → C | D
B → 1B | 1
C → 0C | 0
D → 2D | 2

Solution:

The grammar has no useless productions as every variable i.e A,B,C,D are reachable from S.
Eliminating unit productions: S→ A,A→ C,A→ D
S→ 0C|0|2D|2
A→ 0C|0|2D|2
B→ 1B|1
C→ 0C|0
D→ 2D|2

Eliminating useless variables A(not reachable from S.) after eliminating unit productions,
S→ 0C|0|2D|2
B→ 1B|1
C→ 0C|0
D→ 2D|2

</td><td>2</td></tr>
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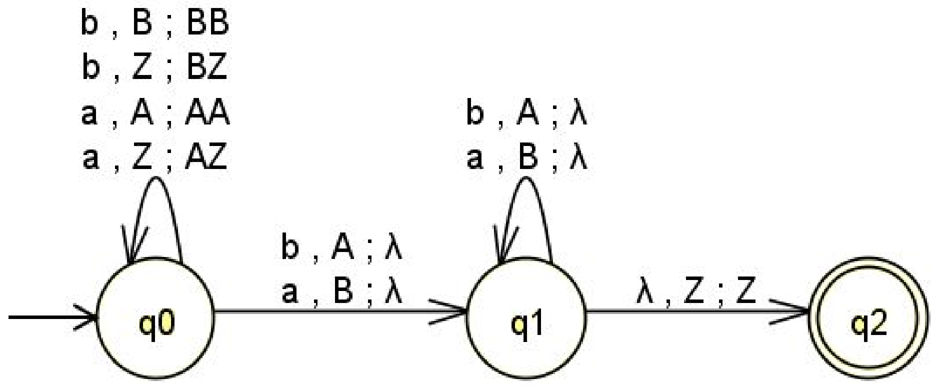
b

What is the language of the given PDA ? **4**



Solution:

L={$a^n b^n$ or $b^n a^n$,n>=1}

c

Use CYK algorithm to fill the table using the following grammar **4**

S → AP | AB

E → AP | EB | b

P → EB

A → a

B → b

Φ				
		E,P		
Φ		E,P		
A	A			
a	a	b	b	b

Solution:

Φ				
Φ	S			
Φ	S	E,P		
Φ	S	E,P	E,P	
A	A	B,E	B,E	B,E
a	a	b	b	b

Acknowledgement : The sample paper solution is prepared by Prof. Sangeeta V I.