TCS Question Sheet

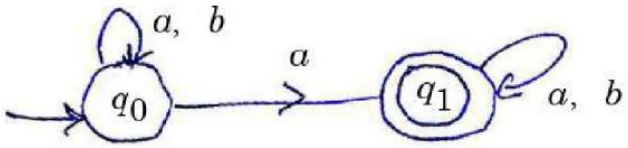
- *One Marker*

1. Let

   A = {1, 2} and B = (2, 3}.

   Find 2^A.

2. Define useless symbol.
3. Express in English, the language accepted by given FA and write the regular expression:

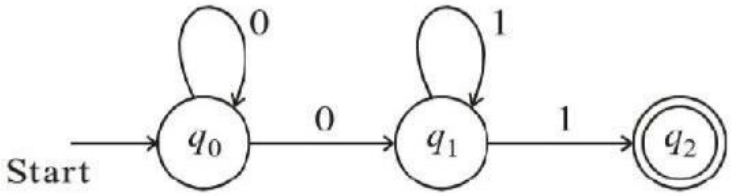


4. State true or false: R + R = R ? Justify.
5. Find CFG for the language represent by the following regular expression:

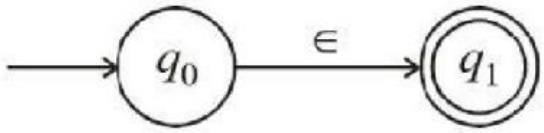
   (O + 1)* 01 (0 + 1)*.

6. Define context sensitive grammar.
7. State two differences between TM and LBA.
8. Define recursively enumerable languages.
9. Write smallest possible string accepted by the regular expression:
   01 + (0 + 11) 0 * 1.
10. Write formal definition of DPDA.
11. What are the proper prefixes and proper suffixes of the string “India”?

12. Define left linear and right linear grammar.
13. Write the regular expression for the following FA:

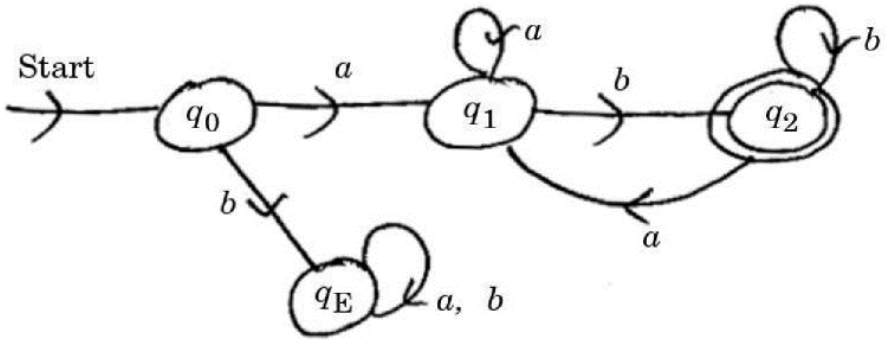


14. Compare λ function of Melay and Moore machine.
15. Write down the 'ε-closure' of each state from the following FA:



16. State the two different ways to simplify the CFG.
17. State the machines used for context free grammar and context-sensitive grammar.
18. Differentiate between PDA and FA.
19. Define tuples of LBA.
20. State pumping lemma of regular set.
21. Define regular expression.
22. Give the mapping of '8' function of NFA with ε moves.
23. If A = {ε}. Find the value of |A|.
24. Which tool is used to prove that the language is not regular?
25. Differentiate between Moore and Mealy machine.

26. Give the language accepted by the following FA:



27. Define Kleene Closure.
28. Write the tuples of Turing Machine.
29. Define ID for PDA.
30. Write a language for CFG:

$$S \rightarrow aSa \mid bSb \mid a \mid b \mid \in$$

31. Write regular expression for the set of all strings of a's and b's ending with ab over $\sum$ = {a, b}
32. Define suffix of a string. Give one example.
33. "DFA cannot have more than one final states." Justify.
34. Write output function λ of Moore and Mealy machines.
35. Write any two closure properties of regular expression.
36. Define ambiguous grammar.
37. Name the type of languages accepted by Pushdown Automata.
38. Define non-deterministic Turing Machine.
39. What is unit production?
40. Consider the following grammar:

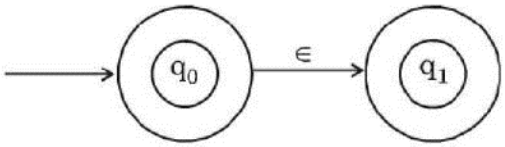
    S -> ADa

    A -> a

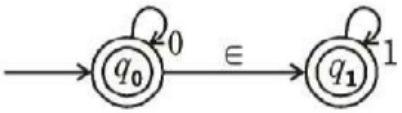
    D -> d

    The grammar is in CNF. Justify.
41. Define Turing Machine (T.M.).
42. Define suffix of a string. Give one example.

43. Compare 'λ' function of Melay and Moore machine.
44. DFA may have many final states. Comment.
45. Write down the 'E-closure' of each state from the following FA:

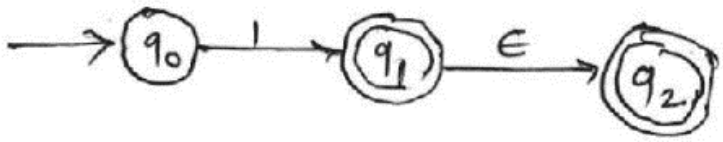


46. Define ambiguous grammar.
47. Write a mapping of δ in PDA.
48. State two differences between TM and LBA.
49. Write the smallest possible string accepted by regular expression: (0 + 1)* 01*.
50. What are the types of grammar in Chomsky hierarchy?
51. What are the proper prefix and proper suffix of the string "India"?
52. Define DFA.
53. Write down the e¢€-closure of each state from the following FA:



54. Write smallest possible string accepted by the following regular expression: (0l + 10*)* 1.
55. Every recursive language is recursively enumerable. (True or False) justify.
56. (f Write formal definition of DPDA?
57. Define unit production with example.
58. Define right linear grammar.
59. State two differences between PDA and FA.
60. State lemma 1 for converting a CFG to GNF.

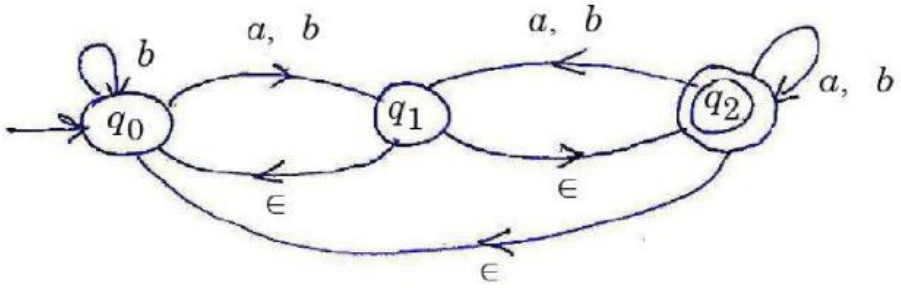
61. What are the proper prefix and proper suffix of the string "Computer"?
62. Write down the ε - closure of each state from the following FA:



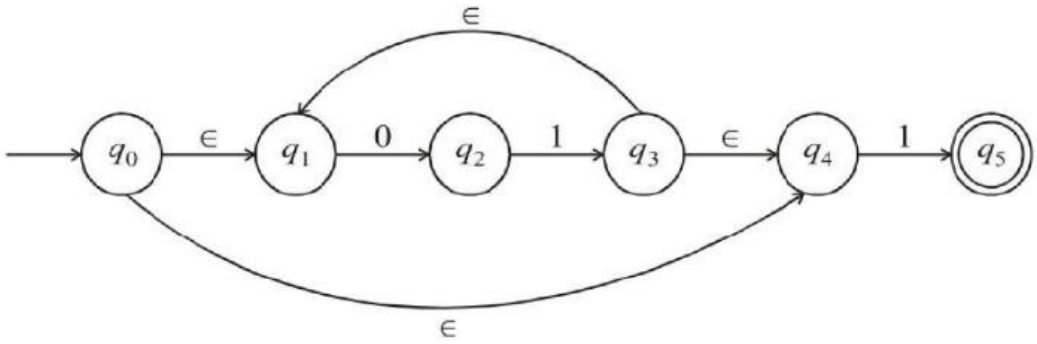
63. Write smallest possible string accepted by the following regular expression. (11)* (00)* + (10+01)*.1
64. Finite Automata has more than one Final states (True or False) Justify.
65. Define context sensitive grammar.
66. Write formal definition of DPDA.
67. Define recursively enumerable language.
68. State lemma 2 for converting a CFG to GNF.
69. State two differences between NFA and DFA.
70. Write the tuples of LBA.

- *Five Marker (first)*

1. Construct FA for regular expression: (ab)* + (a + b)* a* B.
2. Design Mealy machine to determine the residue (remainder) mod 3 for a decimal number.
3. Construct DFA for the following NFA with ε-moves.

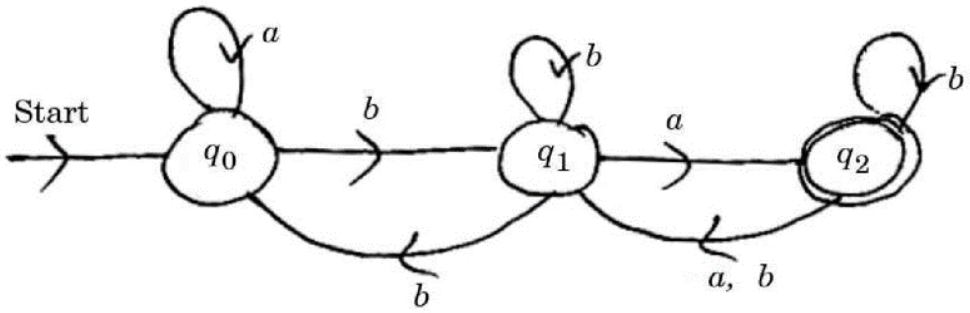


4. Construct a DFA to accept all decimal numbers divisible by 3.
5. Construct DFA equivalent to the following NFA:



6. Construct FA for the following regular expression: (010 + 00)* (10)*.
7. Construct a DFA to accept the set of all strings over > = {0, 1, 2} such that the string ends with ‘012’ or ‘20’.
8. Construct a FA for the given RE: (a*b + b*a).ab + ba.b*.

9. Convert the following given NFA to DFA:



10. Convert the following grammar in GNF:

    S -> aAS I a

    A -> SbA I SS | bA

11. Construct DFA to accept substrings having both aa and bb over Σ = {a, b}.
12. Construct PDA for language: L = $\{a^m b^n \mid m > n \geq 1\}$
13. Construct DFA for L = $L_1 \cap L_2$ where

    L_1 = all strings starting with 'b' over {a, b}

    L_2 = all strings not having 'ba' as substring over {a, b}.

14. Convert the following grammar in CNF:

    S -> ABA

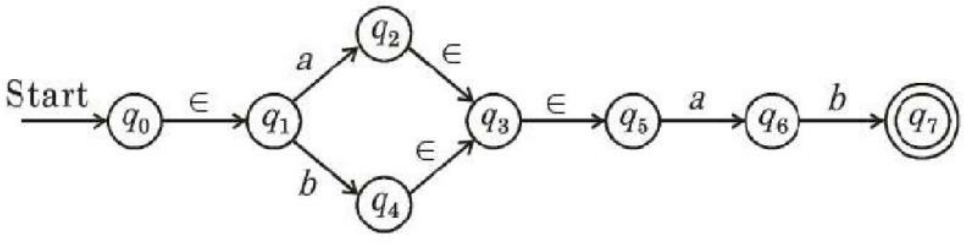
    A -> aA/ε (epsilon)

    B -> bB/ε (epsilon).

15. Construct PDA for language:

    L = $\{a^n b^{2n+1} \mid n \geq 1\}$.

16. Construct DFA containing all string starting with 01 and having 012 as substring.
17. Construct FA for regular expression: (01)* + (0 + 1)* 0* 1.
18. Convert the following NFA with © moves to DFA:

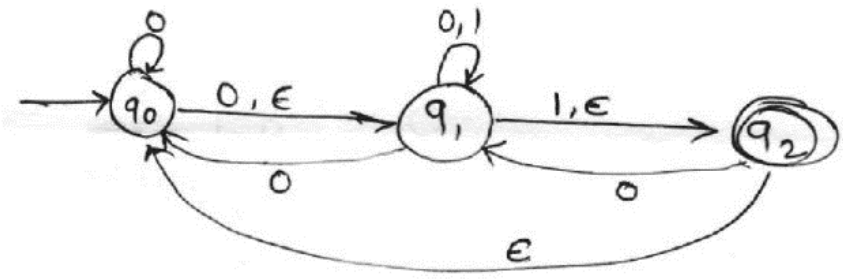


19. Construct a DFA for a language

    L = {x | x has neither “aa” nor “bb” as a substring} over Σ = {a, b}.

20. Construct FA for regular expression: (0+ 1)* 01 + (1+0)* 11

21. Convert the following NFA with ε moves to DFA.



- *Five Marker (second)*

1. Show that context free languages are closed under union with an example.
2. Construct PDA for a language:

   L= {W ⊂ W^R | W € (0+1)*}.
3. Construct TM for a language:

   L = {a^n b^m c^n | m, n >= 0}.
4. Define PDA and construct PDA for L = {a^n b^m a^n | m, n ≥ 1).
5. Construct the following CFG into Chomsky Normal Form (CNF):

   S -> ABA

   A -> aA I ε (epsilon)

   B -> bB I ε (epsilon)
6. Construct CFG for the following:
   a. L = { a^x b^y c^{x+y} | x, y ≥ 1}
   b. A language containing string having at least one occurrence of '00' over {0, 1}.
7. Questions
   a. Construct CFG for language

      L = {$a^n b^m c^m d^n$ | n ≥ 1, m ≥ I}.

   b. Construct CFG for language L which accepts set of all palindromes over Σ = {a, b}.
8. Rewrite the following CFG after eliminating useless symbols:

   S -> 0A0

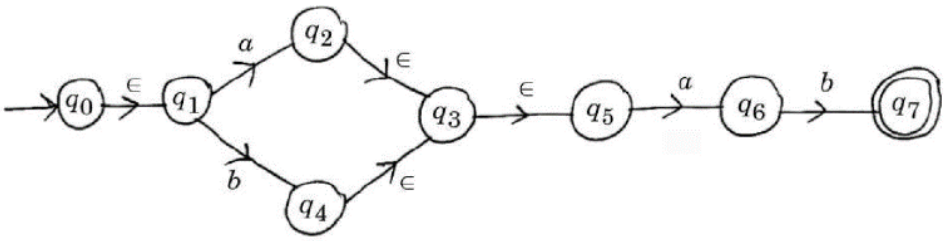
   A -> s1 | 1CC | D0A

   C -> 011 | DD

   E -> 0C

   D -> 0DA

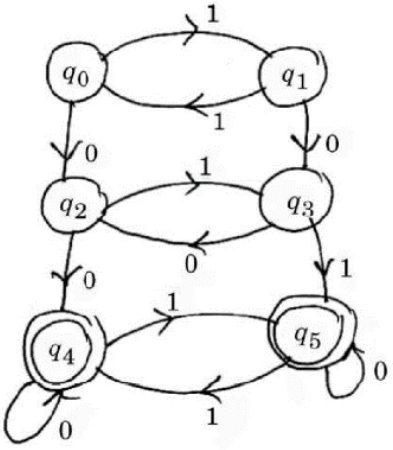
9. Construct a TM for L = {wcw^R | w € (a + b)*}.
10. Convert the following NFA to DFA:



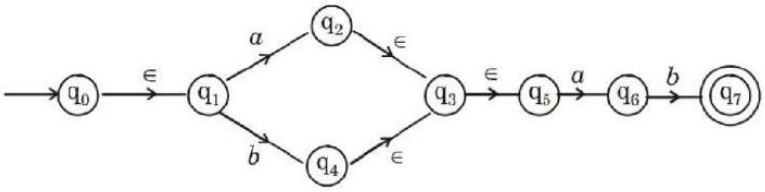
11. Construct Turing Machine for language:

L = {$a^n b^n a^n$ | n ≥ 1}

12. Minimize the following DFA using Myhill-Nerode theorem:



13. Convert the following NFA to DFA:



14. Construct TM accepting language:

L = {$a^n b^m e^{m+n}$ | m, n ≥ 0}.

15. Convert the following grammer in GNF:

S -> AB | B

A -> BS

B -> AI | I

16. Construct a PDA for L = {$a^2 b^{2n} c^k$ | n ≥ 1, k ≥ 1}.
17. Construct the following CFG into Chomsky Normal Form (CNF): S -> aSa I bSb I a I b I aa I bb

18. Construct CFG for the following:
    a. $L = \{a^n b^{n+2} \mid n >= 0\}$
    b. A language containing string having at least one occurrence of 11 over (0, 1).
19. Construct CFG for the following
    a. $L_1 = \{0^n 1^n 2^m \mid n \geq 1, m \geq 0\}$
    b. $L_2 = \{0^n 1^m \mid n, m \geq 0\}$
20. Construct TM for language
    $L = \{a^m b^n \mid n \geq m, m \geq 1\}$
21. Construct the following CFG into Chomsky Normal Form (CNF)

    S -> AaB | a

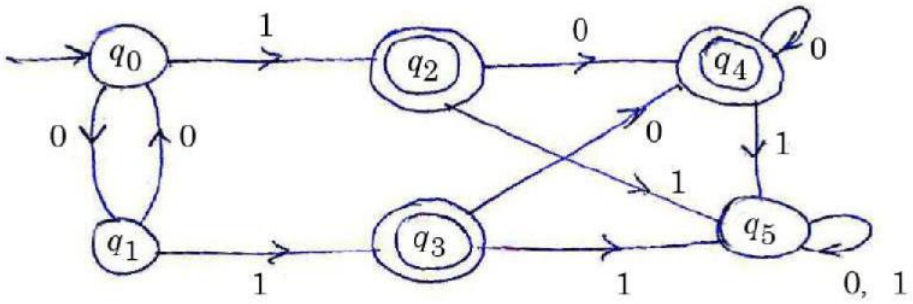
    A -> SBb | bA

    B -> Ba | b

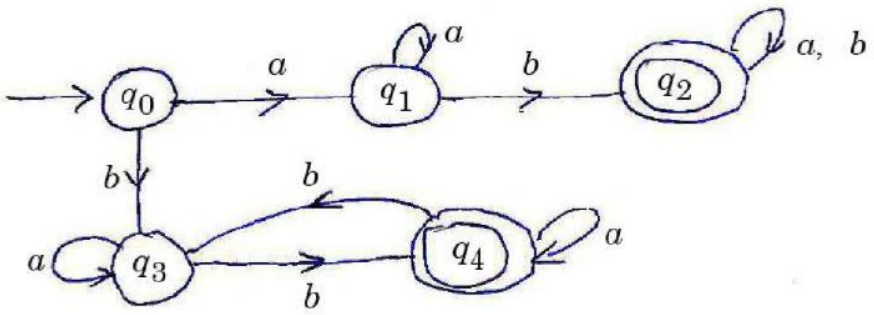
- *Ten Marker*

1. Questions
    a. Find minimum state FA equivalent to the following DFA: [4]

$$M = (\{q_0, \ldots, q_5\}, \{0, 1\}, \delta, q_0, \{q_2, q_3, q_4\}).$$



    b. Construct regular grammar for the following DFA. [4]



    c. Define left linear and right linear grammar. [2]

2. Questions
    a. Convert the following CFG into CNF (Chomsky normal form): [4]

        S -> bA I aB

        A -> bAA | aS I a

        B -> aBB | bS | b

    b. Determine whether the following language is regular? Justify: [4]

        $L = L_1 \cap L_2$

$$L_1 = \{a^n\ b^m \mid n \geq m \text{ and } n > 0\}$$

where: $L_2 = \{b^m\ a^n \mid m > 0,\ n > 1\}.$

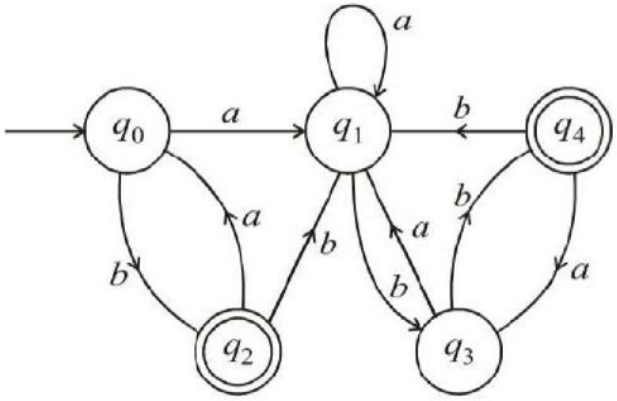
c. Construct CFG for L = L_1 L_2 where: [2]

$L_1 = \{a^n\ b \mid n >= 1\}$ and

$L_2 = \{a^n\ b^{n+2} \mid n >= 0\}$

3. Questions

a. Minimize the following DFA: [4]



b. Explain the types of Turing Machine (TM). [4]

c. Explain any one closure property of regular set. [2]

4. Questions

a. Construct TM for L = $\{ww^R \mid w \in (0+1)^*\}$. [4]

b. Convert the following CFG into PDA: [4]

S -> 1S | 1S0S I 1

Also show that the string "11101" is accepted by the PDA.

c. Define the terms: [2]

i. Ambiguous grammar

ii. Parse tree.

5. Questions

a. Construct a Moore machine for a language L over Σ = {0, 1} which outputs '$' if string ends with '100',

outputs '#' if string ends with '001', otherwise outputs '*'. [5]

b. Construct a PDA for L = $\{0^m1^n2^n0^m \mid m \geq 1, n = 1\}$. [5]

c. [5]

i. Define Recursive language.

ii. Differentiate between recursive and recursively enumerable languages.

6. Questions

a. Convert the following grammar to GNF: [5]

S -> AB | B

A -> BS

B -> A1 | 1

b. Construct PDA equivalent to the given CFG: [5]

S -> aAb | aS

A -> Bb I a

B -> Sa | b

c. Minimize the following DFA: [5]

$M = (\{q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_7\}, \{0, 1\}, \delta, q_0, \{q_1\})$

where δ is given by :

	δ	0	1
$\rightarrow$	q_0	q_4	q_0
	$^*q_1$	q_1	q_0
	q_2	q_1	q_3
	q_3	q_7	q_2
	q_4	q_0	q_5
	q_5	q_1	q_4
	q_6	q_7	q_1
	q_7	q_3	q_7

7. Questions

a. Construct Moore and Mealy machines which outputs valid for valid strings and invalid for invalid strings for language L = a(a + b) * b. [4]

b. Construct NFA for regular expression 1.0* + 0*.1. [3]

c. How to apply pumping lemma to prove certain languages are non-regular? [3]

8. Questions

a. Construct CFG for the language L = L_1L_2 where: [4]

$L_1 = \{a^n b \mid n \geq 0\}$

$L_2 = \{b^m c \mid m \geq 0\}$.

b. Write a short note on Chomsky's hierarchy. [4]

c. Consider the following grammar: [2]

S -> AB | aD | a

A -> a

D -> aD | aDD

Remove useless symbols and rewrite the grammar.

9. Questions

a. Construct the min DFA for the following DFA [4]

M = $(\{q_0, q_1, q_2, q_3, q_4\}, \{a, b\}, \delta, q_0 \{q_2, q_4\})$

	δ	a	b
Start →	q_0	q_1	q_2
	q_1	q_1	q_3
Final	$\leftarrow q_2$	q_0	q_1
	q_3	q_1	q_4
Final	$\leftarrow q_4$	q_3	q_1

(Use Myhill Nerode Theorem).

b. Construct FA for the following regular expression: (010 + 00)* (10)*. [4]

c. Explain types of regular grammar. [2]

10. Questions

a. Construct Moore machines for binary input sequence such that if it has a substring 101, the machine output 'A', if it has substring 110 then output 'B' else output 'C'. [4]

b. Construct CFG for; [4]

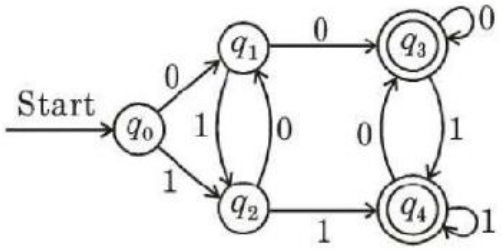
i. $\{a^n b^m \mid n, m \geq 0\}$

ii. $\{a^n b^n c^i \mid n \geq i, i \geq 0\}$.

c. Differentiate between FA and PDA. [2]

11. Questions

a. Construct minimal DFA for the following: [4]



b. Design a TM to recognize well-formedness of parenthesis ( ). [4]

c. Define the following terms: [2]

i. kleen closure

ii. parse tree.

12. Questions

a. Construct Mealy machine to convert each occurrence of substring 101 by 100 over alphabet {0,1}. [4]

b. Construct PDA that accepts language as S -> aS | aSbS | a. [4]

c. Show that CFL's are closed under union. [2]

13. Questions

a. Construct minimal DFA for the following: [4]

M = ({A, B, C, D, E}, {0, 1}, δ, A, {E})

when δ is given by

	δ	0	1
→	A	B	C
	B	B	D
	C	B	C
	D	B	E
*	E	B	C

b. Construct PDA for L= $\{a^n b^{2n+1} \mid n \geq 1\}$ [4]

c. Define the following terms: [2]

   i. Kleene closure.

   ii. Derivation tree.

14. Questions

a. Construct a mealy machine to convert each occurrence of substring 101 by 100 over alphabet {0,1}. [4]

b. Construct PDA equivalent to the given CFG [4]

   S -> bAB | aB

   A -> aAB I a

   B -> aBB | b

c. Show that CFL's are closed under concatenation. [2]