53 (CS 502) THCM

2014

THEORY OF COMPUTATION

Paper : CS 502

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer ***question no. 1*** *and* ***any four (4)*** *from the rest.*

1. *(a)* Define a finite automaton.

   (b) Enumerate the difference between DFA and NDFA.

   (c) Construct a finite automaton for the regular expression 0*1*.

   (d) Mention the closure properties of regular languages.

   (e) What do you mean by a derivation tree for a context free grammar ?

   (f) When we say a grammar to be ambiguous ?

(g) State pumping lemma for context free languages.

(h) Define a Turing machine.

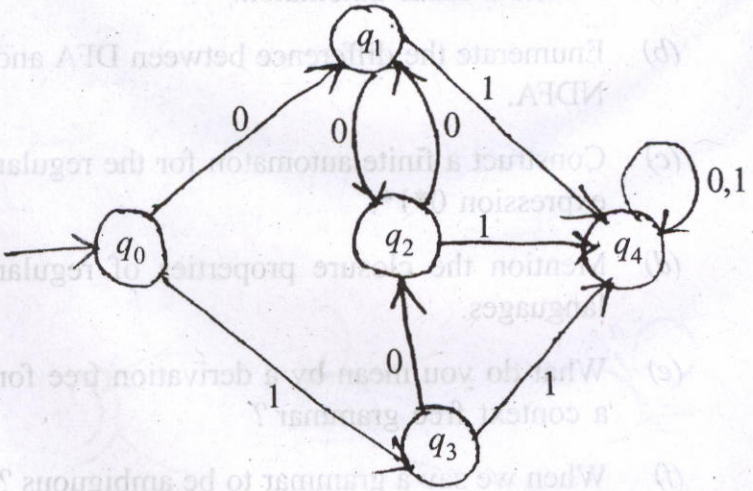
(i) What do you mean by a linear bounded automaton ?

(j) When a language is said to be recursively enumerable ? 10×2=20

2. (a) Design a DFA to accept the language

$L = \{w \mid w$ has both an even no. of 0's and even no. of 1's$\}$ 4

(b) Minimize the finite automaton shown in the figure below : 8



(c) Discuss the Chomsky classification of grammars and explain each of the types explicitly. 8

3. (a) Find the highest type number which can be applied to the following productions : 3

$$S \rightarrow Aa,\ A \rightarrow c \mid Ba,\ B \rightarrow abc$$

(b) Construct a context-free grammar generating

$$L = \left\{ a^n b^{2n} \,\middle|\, n \geq 1 \right\}$$ 3

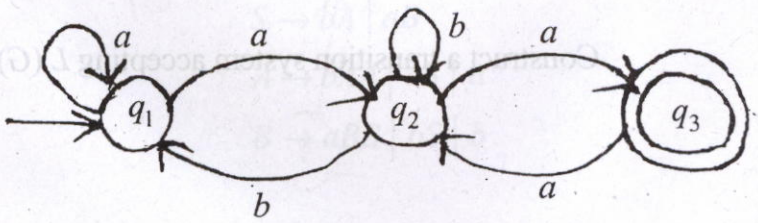
(c) Discuss regular expressions. 4+4=8

Prove that

$$(1 + 00^*1) + (1 + 00^*1)\,(0 + 10^*1)^*\,(0 + 10^*1)$$

$$= 0^*1\,(0 + 10^*1)^*$$

(d) Consider the transition system given in the figure below. Prove that the strings recognized are $(a + a(b + aa)^* b)^* a(b + aa)^* a$ 6



4. *(a)* Construct a DFA with reduced states equivalent to the regular expression 10

$$10+(0+11)\,0*1$$

(b) Prove that $(a+b)^* = a*(ba*)*$ 10

5. *(a)* Construct a regular grammar G generating the regular set represented by 6

$$P = a*b(a+b)^*$$

(b) Let $G = (\{A_0, A_1, A_2, A_3\}, \{a, b\}, P, A_0)$ where P consists of 4

$$A_0 \to aA_0 \mid bA_1$$
$$A_1 \to aA_2 \mid aA_3$$
$$A_3 \to a \mid bA_1 \mid bA_3$$
$$A_3 \to b \mid bA_0$$

Construct a transition system accepting $L(G)$.

(c) Construct the following grammar : 2+2=4

$$S \rightarrow aB \mid bA$$
$$A \rightarrow a \mid aS \mid bAA$$
$$B \rightarrow b \mid bS \mid aBB$$

Find the string *aaabbabbba*, find

(i) Leftmost derivation

(ii) Rightmost derivation.

(d) Given grammar $G = (\{S\}, \{a, b, +, *\}, P, S)$ where P consists of

$$S \rightarrow S + S \mid S * S \mid a \mid b$$

Show that G is ambiguous. 6

6. (a) Define Chomsky Normal Form (CNF). Find an equivalent grammar in CNF for the grammar $G = (\{S, A, B\}, \{a, b\}, P, S)$ with productions P given by — 3+5=8

$$S \rightarrow bA \mid aB$$
$$A \rightarrow bAA \mid aS \mid a$$
$$B \rightarrow aBB \mid bS \mid b$$

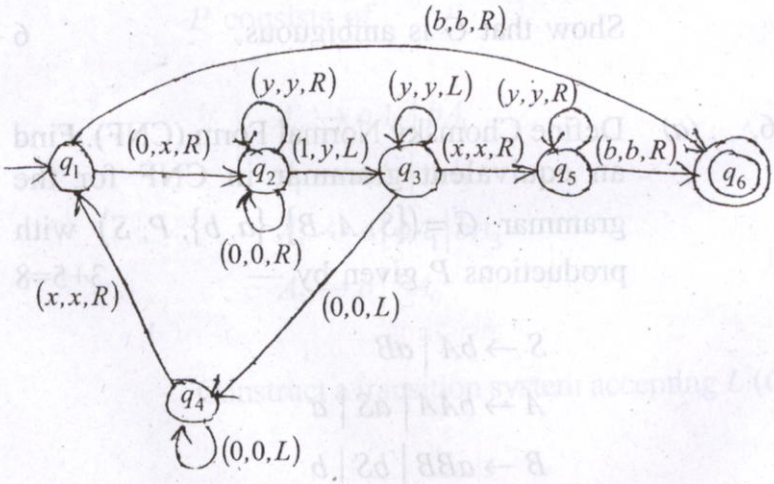
(b) Define push down automata (PDA). 4

(c) Construct a PDA A accepting 4+4=8

(i) the set of all strings over $\{a, b\}$ with equal no. of a's and b's.

(ii) $L = \left\{ wc\, w^T \;\middle|\; w \in \{a, b\}^* \right\}$ by final state.

7. (a) M is a Turing machine represented by the transition system given below. Obtain the computation sequence of M for processing the input string 0011. 6



(b) Consider the Turing machine M described by the transition table given below. 9

Describe the processing of *(a)* 011 *(b)* 0011 and *(c)* 001. Which of the above strings are accepted by M ?

Present State	Tape Symbol				
	0	**1**	***x***	***y***	***b***
$\rightarrow q_1$	xRq_2				bRq_5
q_2	ORq_2	yLq_3		yRq_2	
q_3	OLq_4		xRq_5	yLq_3	
q_4	OLq_4		xRq_1		
q_5				$yxRq_5$	bRq_6
(q_6)					

(c) Design a Turing machine to recognize all strings consisting of even no. of 1's. 5