53 (IT 503) THCP

2017

THEORY OF COMPUTATION

Paper : IT 503

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions out of **eight**.*

1. *(a)* Define the following with examples : 3×2

   (i) alphabet

   (ii) String

   (iii) Language

   (b) Draw the DFA for the following languages. 5+5

   (i) Languages over the alphabet $\Sigma=\langle 0,1\rangle$ that have the set of all strings that either begins or ends or both with '01'.

(ii) Languages over the alphabet $\Sigma=\langle 0,1\rangle$ that have the set of strings, where all strings have second last symbol from the start is '0' and second last symbol from the end is '1'.

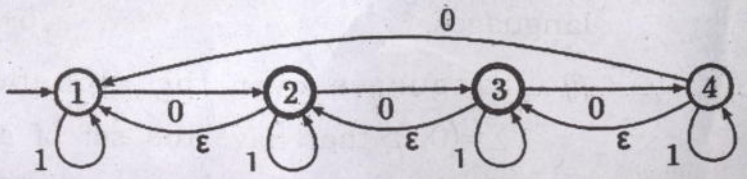
(iii) Define Chomsky hierarchy of languages. 4

2. (a) Prove that the following grammar of arithmetic expressions is ambiguous.

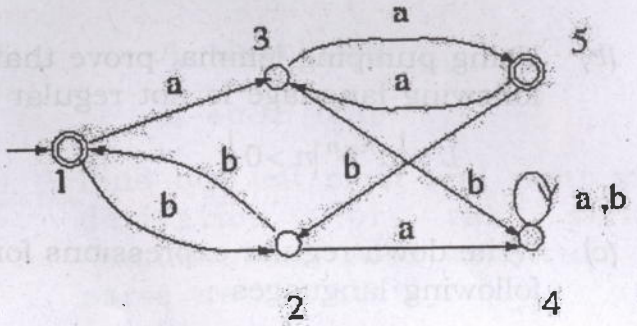
$$E \rightarrow E+E|E*E|(E)|id$$ 6

(b) Describe the differences between context free and context sensitive grammar. Describe the basic defects of context free grammar. 4+2

(c) Consider the following NFA with Epsilon (ε) transition and convert it into NFA without Epsilon transition. 8



3. (a) Obtain minimum state DFA equivalent to the following DFA : 8



(b) Differentiate between DFA and NFA with suitable example. 4

(c) Construct a context free grammar G, which accepts N(A) where 8

$A=(\{q_0,q_1\},\{a,b\},\{z_0,z_1\}\delta,q_0,z_0,\phi)$

δ is given by

$$\delta(q_0,b,z_0)=\{(q_0,zz_0)\}$$
$$\delta(q_0,\varepsilon,z_0)=\{(q_0,\varepsilon)\}$$
$$\delta(q_0,b,z)=\{(q_0,zz)\}$$
$$\delta(q_0,a,z)=\{(q_1,z)\}$$
$$\delta(q_1,b,z)=\{(q_1,\varepsilon)\}$$
$$\delta(q_1,a,z_0)=\{(q_0,z_0)\}$$

4. *(a)* Define Regular Expression and its importance in automata theory. 3+2

(b) Using pumping lemma, prove that the following language is not regular : 6

$$L = \{a^n b^n \mid n > 0\}$$

(c) Write down regular expressions for the following languages : 3×3

(i) Set of all strings over the alphabet $\Sigma = \{0,1\}$ such that the second last symbol from end is '1'.

(ii) Set of all strings over the alphabet $\Sigma = \{0,1\}$ such that each string, if starts with '0' then ends with '1' or, if starts with '1' then ends with '0'.

(iii) Set of all strings over the alphabet $\Sigma = \{0,1\}$ such that each string not containing '101'.

5. *(a)* Define right-linear grammar and left-linear grammar. 4

(b) Consider the following grammar :

$$S \rightarrow bA \mid aB$$

$$A \rightarrow bAA \mid aS \mid a$$

$$B \rightarrow aBB \mid bS \mid b$$

Find out left most and right most derivation for the string, *'baaabbabba'*. Also construct the parse tree for that. 6+2

(c) Obtain Greiback normal form equivalent to the following context free grammar. 8

$$S \rightarrow XA \mid BB$$
$$B \rightarrow b \mid SB$$
$$X \rightarrow b$$
$$A \rightarrow a$$

7. *(a)* When a problem is said to be decidable or undecidable ? Show that problem "given an arbitrary turing machine M and arbitrary string W, does M halts on W" is undecidable. 4+4

(b) Convert the following grammar into CNF 7

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

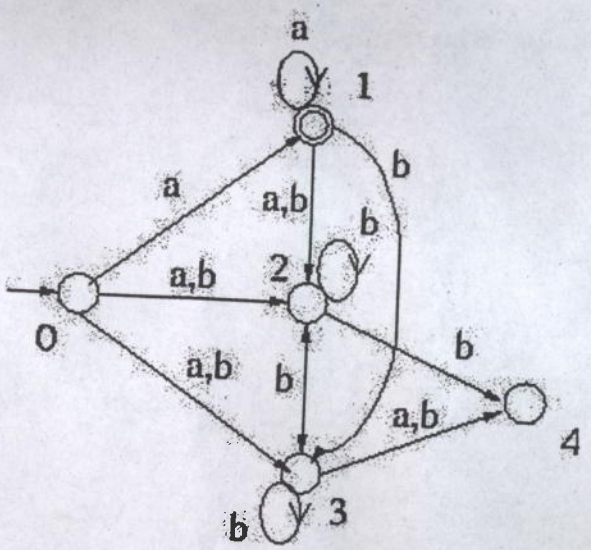
(c) Construct an automata for the regular expression

$$a.(a^* + b^*)$$ 5

8. (a) Remove all ε and unit production rules from the following *CFG* : 8

$$S \rightarrow AaA \mid CA \mid BaB$$
$$A \rightarrow aaBa \mid CDA \mid aa \mid DC$$
$$B \rightarrow bB \mid bAB \mid bb \mid aS$$
$$C \rightarrow Ca \mid Bc \mid D$$
$$D \rightarrow bD \mid A$$

(b) Construct the DFA equivalent to the following NFA : 8



(c) When a language is said to be recursive or recursively enumerable ? 4