

## Con. 3433-09. Theoretical Computer Science

VR-5115

(REVISED COURSE)

(Lib)

(3 Hours)

[Total Marks : 100]

- N.B. :** (1) Question No.1 is **compulsory**.  
 (2) Solve any **four** questions out of remaining **six** questions.  
 (3) **All** questions carry **equal** marks.  
 (4) Assume **suitable data** if **required**.  
 (5) **Figures** to the **right** indicate **full** marks.

1. Solve the followings :—

- (a) State the pumping lemma for regular language and prove that  $L = \{ 0^{2n} \mid n \geq 1 \}$  is not regular. 5
- (b) Design a Mealy machine that accepts an input from  $(0 + 1)^*$ , if the input ends in 101, output A; if the input ends in 110, output B; otherwise C. 5
- (c) Let  $G = (V, T, P, S)$  be the CFG having following set of productions. Derive the string "aabbaa" using leftmost derivation and rightmost derivation. 5
- $$S \rightarrow aAS \mid a$$
- $$A \rightarrow SbA \mid SS \mid ba$$
- (d) Write a short note on Universal Turing Machine. 5

2. Solve the followings :—

- (a) Construct an NFA with  $\epsilon$  - moves for the regular expression  $10(0 + 01 + 0110)^*$  6
- (b) Find the equivalent DFA accepting the regular language defined by the right linear grammar given as— 14

$$S \rightarrow aA \mid bB$$

$$A \rightarrow aA \mid bC \mid a$$

$$B \rightarrow aB \mid b$$

$$C \rightarrow bB$$

3. Solve the followings :—

- (a) Given a CFG  $G$ , find  $G'$  in Chomsky normal form generating  $L(G) - \epsilon$ . 10
- $$S \rightarrow ASB \mid \epsilon \quad A \rightarrow AaS \mid a \quad B \rightarrow SbS \mid A \mid bb$$
- (b) Construct left linear and right linear grammar for the regular expression  $(((01 + 10)^* 11)^* 00)^*$ . 6
- (c) Write short note on ambiguity resolution. 4

4. Solve the followings :—

(a) Design a PDA for CFL that checks the well formedness of parenthesis i.e. the language L of all “balanced” string of two types of parenthesis say “( )” & “[ ]”. Trace the sequence of moves made corresponding to input string  $(([ ])[ ])$ . 8

(b) Construct a PDA that will accept a CFL generated by the following :— 8  
CFG  $G = (V, T, P, S)$  having the following set of productions—

$$S \rightarrow AB \mid ABC$$

$$A \rightarrow BA \mid BC \mid \epsilon \mid a$$

$$B \rightarrow AC \mid CB \mid b \mid \epsilon$$

$$C \rightarrow BC \mid AB \mid c$$

(c) Give context free grammar generating the following sets. 4

(i) The string containing no consecutive ‘b’s but ‘a’s can be consecutive.

(ii) The set of all strings over alphabet  $\{a, b\}$  with exactly twice as many a’s as b’s.

5. Solve the followings :—

- (a) Construct a Turing machines M to accept the language  $L = \{wcw^R \mid w \in \{0, 1\}^*\}$  and  $w^R$  means reverse of  $w$ . Trace the sequence of moves made corresponding to input string 0lcl0 10
- (b) Construct a turing machine M for performing proper subtraction  $m-n$  is defined to be  $m-n$  for  $m \geq n$  and zero for  $m < n$ . The TM started with  $0^m 10^n$  on its tape, halts with  $0^{m-n}$  on its tape. Trace the sequence of moves for the input string 0000100. 10

6. Solve the followings :—

- (a) Give the context free grammar for the language  $N(M)$  where—  
 $M = (\{q_0, q_1\}, \{0, 1\}, \{X, Z_0\}, \delta, q_0, Z_0, \phi)$ , where  $\delta$  is given by  
 $\delta(q_0, 0, Z_0) = \{(q_0, XZ_0)\}$ ,  $\delta(q_1, 1, X) = \{(q_1, \epsilon)\}$   
 $\delta(q_0, 0, X) = \{(q_0, XX)\}$ ,  $\delta(q_1, \epsilon, X) = \{(q_1, \epsilon)\}$   
 $\delta(q_0, 1, X) = \{(q_1, \epsilon)\}$ ,  $\delta(q_1, \epsilon, Z_0) = \{(q_1, \epsilon)\}$
- (b) Write down the minimization algorithm and using it find out the minimum state finite automaton equivalent to the transition table given below. 10

	→A	B	* C	D	E	* F	G	H	* I
0	B	C	D	E	F	G	H	I	A
1	E	F	H	H	I	B	B	C	E

7. Solve the followings :—

- (a) Explain the undecidability of PCP ? Does PCP with following two list—  
 $A = (10, 011, 101)$  and  $B = (101, 11, 011)$  have a solution ? Justify your answer. 6
- (b) Write short note on Recursive Decent Parser. 4
- (c) Find a Greibach normal-form grammar equivalent to the following CFG. 6  
 $A \rightarrow Bb \mid BB$        $B \rightarrow AB \mid a$        $S \rightarrow BA \mid ab$
- (d) Give DFA accepting the following languages over the character  $(0, 1)$  4  
 (i) The set of all strings ending in 00.  
 (ii) The set of all strings with three consecutive zeros.