Fourth Semester B. E. CSE (CBS) Examination

THEORETICAL FOUNDATION OF COMPUTER SCIENCE

Time : Three Hours] [Max. Marks : 80

N. B. : (1) All questions carry marks as indicated.
(2) Solve Question 1 OR Question No. 2.
(3) Solve Question 3 OR Question No. 4.
(4) Solve Question 5 OR Question No. 6.
(5) Solve Question 7 OR Question No. 8.
(6) Solve Question 9 OR Question No. 10.
(7) Solve Question 11 OR Question No. 12.
(8) Due credit will be given to neatness and adequate dimensions.
(9) Assume suitable data wherever necessary.
(10) Illustrate your answers wherever necessary with the help of neat sketches.

1. (a) Prove the following by principle of Induction :

(i) $1^2+2^2+3^2 + \text{-------} + n^2 = \frac{n\times(n+1)(2n+1)}{6}$

(ii) $1+4+7+ \text{----} +(3n-2) = \frac{n(3n-1)}{2}$

(b) Explain the following terms :

(i) Null Set

(ii) Sub set.

(iii) Proper prefix.

(iv) Proper Suffix. 6

OR

2. (a) Describe the concept of Pigeon hole principle with suitable example. 5

(b) Discuss the Chomsky Hierarchy of language. Identify the type of following grammar :

$AB \rightarrow CDB$

$AB \rightarrow CdEB$

$ABcd \rightarrow abCDeBcd$

$B \rightarrow b$ 6

(c) Explain the concept of Diagonalization. 2

3. (a) Differentiate between NFA and DFA. 5

(b) Design a DFA accepting following language :

$$L = \left\{ w \,/\, w \in (a|b)^* \;\; n_a(w) \bmod 4 \geq n_b(w) \bmod 3 \right\}$$

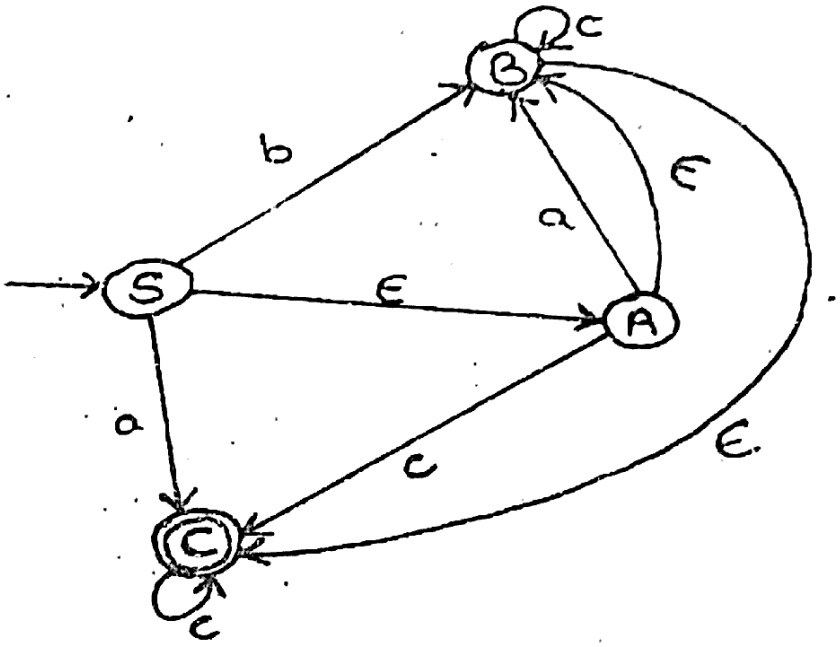
where $n_a(w) \rightarrow$ Number of a's in w

$n_b(w) \rightarrow$ Number of b's in w. 8

OR

4. (a) Convert the following NFA with $\in$ transition into DFA.

[Fig. on Next page]



7

(b) Design Moore and Melay machine that gives "1" as its output if the last three digits are 1's. Assume that $\epsilon = 0, 1$. 6

5. (a) Obtain deterministic finite automata for the following regular expression :

$(0+1)^*10(0+1)^*+(0+1)^*11(0+1)^*$ 8

(b) Obtain right linear grammar equivalent to the following left linear grammar :

$S \rightarrow Sab \ / \ Aa$

$A \rightarrow Abb \ / \ bb$ 6

OR

6. (a) Using Pumping lema, prove that the language :

$L = \{a^{i3} / i \geq 1\}$

is not regular. 4

(b) Find grammar generating :

$L = (0^m\ 1^m\ 2^j \ / \ m \geq 1,\ j \geq 0)$ 6

(c) Find the equivalent CNF for the following grammar:

$S \rightarrow aB \ / \ ab$

$A \rightarrow aAB \ / \ a$

$B \rightarrow ABb \ / \ b$ 4

7. (a) Design PDA for :

$L_4 = \{w\, c\, w^R / \omega \in (a,\ b)^*\}$

w^R = Reverse of w

Also explain the stack execution with valid string. 8

(b) Convert the grammar :

$S \rightarrow$ SOS / SOSOS1S / S1SOSOS / $\in$

to a PDA that accepts the same language by empty stack. 6

OR

8. (a) Design a PDA to accept all string over $L = (a^n b^m c^{|m-n|} | m,\ n >= 1\}$. Explain all the cases 7

(b) Given a grammar for the language N(M), where:

$M = (\{q_0, q_1\}, \{0,1\}, \{z_0, x\}, \delta, q_0, z_0, \phi)$ and δ is given by

$\delta(q_0, 1, z_0) = \{(q_0, x\ z_0)\} \delta, (q_0, \in, z_0) = \{q_0, \in\}$.

$\delta(q_0, 1, x) = \{(q_0, xx)\}$, $\delta(q_1, 1, x) = (q_1, \in)$

$\delta(q_0, 0, x) = \{(q_1, x)\}$, $\delta(q_1, 0, z_0) = \{q_0, z_0\}$

9. (a) Explain the following terms :

(i) Multitape Turing Machine.

(ii) Universal Turing Machine. 5

(b) Design a Turing machine to compute

$$f(m, n) = \begin{cases} m-n & \text{if } m > n \\ 0 & \text{if } m \leq n \end{cases}$$ 8

OR

10. (a) Construct a Turing machine accepting the language:

$L = \{a^n b^{2n} c^n | n \geq 1\}$ 8

(b) Explain the concept of Linear Bounded Automata. 5

11. (a) Define Ackermann's Function. Compute A(1, 1), A(2, 1) and A(2,2). 5

(b) Explain PCP problem and give solution for following :

List	x	y
1	b	b^3
2	ab^3	ba
3	ba	a

6

(c) Explain Unrestricted Grammar. 2

OR

12. (a) Consider the function :

equals $(x, y) = 1$ if $x = y$

$= 0$ if $x \neq y$

Show that this function is primitive recursive. 5

(b) Write a short note on :—

(i) Recursive function.

(ii) Undecidability.

(iii) Blank tape halting problem. 8