B.E. Fourth Semester (Computer Science Engineering) (C.B.S.)

Theoretical Foundations of Computer Science

P. Pages : 3 **NKT/KS/17/7296**

Time : Three Hours Max. Marks : 80

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

1. a) With the help of Mathematical Induction, prove that **8**

1) $1^2 + 2^2 + 3^2 + \ldots\ldots + n^2 = \frac{n(n+1)(2n+1)}{6}$

2) $1.1! + 2.2! + 3.3! + \ldots\ldots + n.n! = (n+1)! - 1$

b) Explain Pigeonhole principle with example. Also explain Generalised pigeonhole principle. **5**

OR

2. a) Explain in detail Chomsky Hierarchy of languages. **6**

b) What is Countability & Diagonalization. **4**

c) Let $R = \{(1,2), (2,3), (3,1)\}$ & **3**
$A = \{1, 2, 3\}$. Find Reflexive, Symmetric & transitive closure of R.

3. a) Design DFA over $\Sigma = \{0, 1\}$ to accept strings containing even number of 0's and 1's. **6**

b) Consider $\in -$NFA. **8**

Q \ Z	$\in$	a	b	c
$\rightarrow p$	--	p	q	r
q	p	q	r	ϕ
$*r$	q	r	ϕ	p

i) Compute $\in -$closure of each state

ii) Compute all the strings of length 3 or less accepted by the automata

iii) Convert to DFA.

OR

4. a) Construct Mealy Machine to compute 2's complement of binary number. Also convert this machine to Moore Machine. **6**

b) Construct Minimum state automata equivalent to given automata. **8**

State	0	1
$\rightarrow q_0$	q_1	q_5
q_1	q_6	q_2
q_2	q_0	q_2
q_3	q_2	q_6
q_4	q_7	q_5
q_5	q_2	q_6
q_6	q_6	q_4
q_7	q_6	q_2

5. Construct F.A. to accept strings over $\Sigma = \{a, b\}$ containing atleast one aba and not containing bbb. **13**

OR

6. a) Check whether given grammar is ambiguous or not. **4**

$S \rightarrow a / Sa / bSS / SbS$

b) Reduce the grammar & find equivalent grammar. **5**

$S \rightarrow aA / aBB$
$A \rightarrow aaA / \in$
$B \rightarrow bB / bbC$
$C \rightarrow B$

c) Convert the following CFG into CNF. **4**

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

7. a) Construct CFG from following PDA. **10**

$\delta(q_0, 1, Z_0) \rightarrow (q_0, XZ_0)$
$\delta(q_0, 1, X) \rightarrow (q_0, XX)$
$\delta(q_0, 0, X) \rightarrow (q_1, X)$
$\delta(q_0, \in, Z_0) \rightarrow (q_0, \in)$
$\delta(q_1, 1, X) \rightarrow (q_1, \in)$
$\delta(q_1, 0, Z_0) \rightarrow (q_0, Z_0)$

b) Explain the model of PDA. **4**

OR

8. a) Convert the CFG into PDA. **6**

$E \rightarrow aAB / d$
$A \rightarrow BA / a$
$B \rightarrow Ead / C$

b) Design PDA for **8**

$$h = \left\{ WW^R \big/ W \in \{a, b\}^* \right\}$$

9. a) Explain in detail, types of Turing Machines. **6**

b) Design Turing Machine for **7**

$$h = \left\{ a^n b^n c^n \big/ n \geq 1 \right\}$$

OR

10. a) Design a Turing Machine for multiplication of unary numbers. **9**

b) Give the model of LBA and define it formally. **4**

11. a) What is Post Correspondence Problem? Explain with example. Also explain modified PCP. **6**

b) Define Ackermann's function. Compute A (1, 1), A (2, 1), A (2, 2) **7**

OR

12. a) Explain properties of Recursively Enumerable Languages. **5**

b) Write a note on Recursive function. **3**

c) Explain Halting Problem. **3**

d) Define Decidability & Undecidability. **2**

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