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

Theoretical Foundations of Computer Science

P. Pages : 3 **NIR/KW/18/3381**

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. Assume suitable data whenever necessary.

1. a) Explain closure of a Relation. Find R^* for $R = \{(1,1)\ (1,2)\ (2,1)\ (2,3)\ (3,2)\}$. **3**

b) Prove the following relation using principle of Induction : **8**

i) $1.2.3 + 2.3.4 + ... + n(n+1)(n+2) = \dfrac{n(n+1)(n+2)(n+3)}{4}$

ii) $1^2 + 2^2 + 3^2 + ... + n^2 = \dfrac{n(n+1)(2n+1)}{6}$

c) What is countability? Explain. **2**

OR

2. a) Describe the concept of Pigeon – hole principle with example. **5**

b) Define the following **any four.** **8**

i) Transitive Closure.

ii) Reflexive Transitive Closure.

iii) Prefix of String.

iv) Suffix of String.

v) Substring.

vi) Subsequence

3. a) Design a DFA to accept all the natural numbers divisible by 3. **6**

b) Construct a Mealy machine to find 2's complement of a given binary number. Assume that given binary number is presented from LSB to MSB. Also, convert the resultant Mealy machine into its equivalent Moore machine. **8**

OR

4. a) Convert the following NFA into its equivalent DFA. **6**

Q/Σ	0	1
$\rightarrow p$	p	p, q
$*q$	r	r
r	-	s
$*s$	s	s

b) Construct a minimum state automaton equivalent to a given automaton M whose transition table is given by, **8**

State / Σ	a	b
$\rightarrow q_0$	q_0	q_3
q_1	q_2	q_5
q_2	q_3	q_4
q_3	q_0	q_5
q_4	q_0	q_6
q_5	q_1	q_4
q_6	q_1	q_3

5. a) Reduce the following grammar. **5**

$S \rightarrow aA / aBB$

$A \rightarrow aaA / \in$

$B \rightarrow bB / bbC$

$C \rightarrow B$

b) Obtain deterministic finite automata for the following Regular expression, **4**

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

c) Check whether the given grammar is ambiguous or not. **4**

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

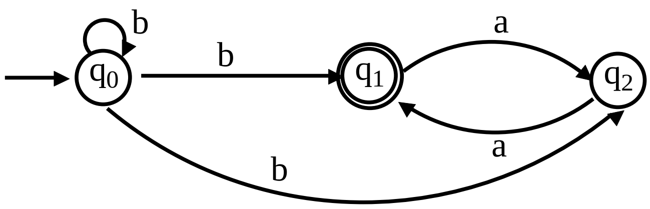
OR

6. a) Convert the following Right linear grammar into left linear grammar. **7**

$S \rightarrow 01A / 10$

$A \rightarrow 10A / 10$

b) Construct a Regular expression from the following finite automata. **6**



7. a) Convert the CFG into PDA. **7**

$E \rightarrow aAB / d$

$A \rightarrow BA / a$

$B \rightarrow Ead / c$

b) Design a PDA for **7**

$L = \{ww^R / w \in \{a, b\}^*\}$

OR

8. a) Convert the given PDA to CFG. **7**

$\delta(q_0, a, z_0) \rightarrow (q_0, x z_0)$

$\delta(q_0, a, x) \rightarrow (q_0, x x)$

$\delta(q_0, b, x) \rightarrow (q_1, \in)$

$\delta(q_1, b, x) \rightarrow (q_1, \in)$

$\delta(q_1, \in, z_0) \rightarrow (q_1, \in)$

b) Using pumping lema, prove that language **7**

$L = \left\{ a^{i^3} \big/ i \geq 1 \right\}$

is not regular.

9. a) Design a Turing machine for the language **6**

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

b) Design a TM to perform multiplication of two unary numbers. **7**

OR

10. a) Explain various types of Turing machines. **6**

b) Design a Turing machine to copy a string over $\Sigma = \{a, b\}^*$. **7**

11. a) Explain post correspondence problem. Consider the post correspondence system described by the following lists. **7**

$A = \{10, 01, 0, 100, 1\}$

$B = \{101, 100, 10, 0, 010\}$

Does this PCP have a resolution?

b) Compute A(1, 1), A(1, 2), A(2, 1) using Ackermann function. **6**

OR

12. Write a short note on : **13**

i) Halting problem of Turing Machine

ii) Linear bounded Automata

iii) Primitive Recursive Function.

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