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

Theoretical Foundations of Computer Science

P. Pages : 3 **NJR/KS/18/4436**

Time : Three Hours * 0 6 0 1 * 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 the following in detail with example. **6**

i) Type – 0 Grammar ii) Type – 1 Grammar

iii) Type – 2 Grammar iv) Type – 3 Grammar

b) What is string, prefix, proper prefix & proper suffix with examples. **4**

c) Write short note on pigeonhole principle. State its application. **3**

OR

2. a) Consider a Relation R = {(a, b), (a, a), (b, b), (c, c), (d, d), (b, a)} on set A = {a, b, c, d}. Is relation R an equivalence relation. If so find equivalence classes. **6**

b) Prove the following using method of induction. **7**

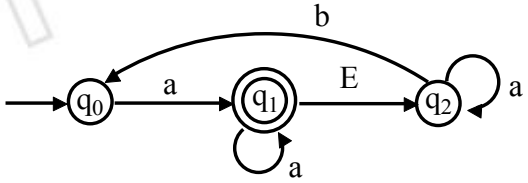
$$\sum_{i=1}^{n} i^2 = \frac{n(n+1)(2n+1)}{6}$$

3. a) Construct DFA which can accept the string those can have odd number of 0's and any number of 1's. **7**

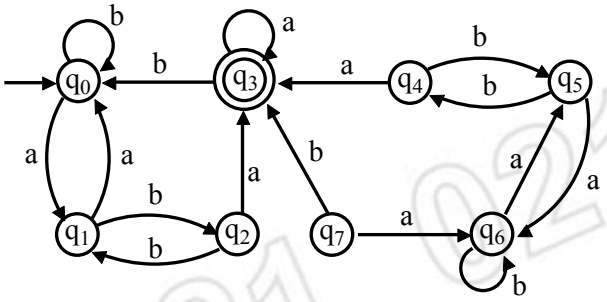
b) Design a Moore machine for binary input sequence, if it ends in 101, output is 'A'. if it ends in 110 output is 'B'. Otherwise C. **6**

OR

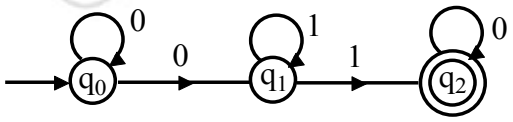
4. a) Convert the following NFA to equivalent DFA. **6**



b) Minimize the following Automata. **7**



5. a) Construct the regular expression for the automata given. **6**



b) Construct context free Grammar for following. Where $(n \geq 0, m \geq 0, k \geq 0)$. **8**

i) $L = \left\{ a^n b^m c^k \mid n = m \text{ or } m \leq k \right\}$.

ii) $L = \left\{ a^n b^m \mid 2n \leq m \leq 3n \right\}$.

iii) $L = \left\{ a^n b^m c^m d^n \setminus m, n \geq 1 \right\}$.

iv) $L = \left\{ a^n b^{2n} \mid n \geq 1 \right\}$.

OR

6. a) Remove all unit productions, all useless production and all E-productions from the grammar given below. **7**

$S \rightarrow aA \mid aBB$

$A \rightarrow aaA \mid \varepsilon$

$B \rightarrow bB \mid bbC$

$C \rightarrow B$

b) Convert the following grammar into Greibach normal form. **7**

$S \rightarrow aSa \mid bBb$

$B \rightarrow abB \mid aaAa$

$A \rightarrow Aa \mid a$

7. a) Construct PDA for $L = \left\{ a^{2n} b^n \mid n > 0 \right\}$. **6**

b) Show that $L = \left\{ a^n b^j \mid n \leq j^2 \right\}$ is not a context free language. **3**

c) Explain the Non-deterministic push down automata in detail. **4**

OR

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

$E \rightarrow aAB \mid d$

$A \rightarrow BA \mid a$

$B \rightarrow Ead \mid C$

b) Explain the modal of PDA and its acceptance by stack and acceptance by final state. **6**

9. a) Explain the types of Turing machine. **5**

b) Construct a Turing machine for. **9**

$f(a, b) = a - b$ if $a \geq b$

$= 0$ if $a < b$

OR

10. a) Explain the modal of linear bounded automata. **5**

b) Construct the Turing machine for **9**

$L = \left\{ a^n b^n a^n b^n \mid n \geq 0 \right\}$.

11. a) Write a short note on: **6**

i) Post correspondence problem.

ii) Primitive Recursive function.

b) Define Ackermann's function. **7**

Compute A (1, 1), A (2, 1), A (2, 2).

OR

12. a) Define Decidability & undecidability. **4**

b) Explain the properties of Recursively enumerable language. Give relation between recursive & recursive enumerable language. **6**

c) Explain Halting problem of Turing machine in detail. **3**

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