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- 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

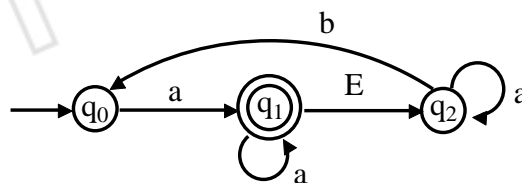
2. a) Consider a Relation $R = \{(a, b), (a, a), (b, b), (c, c), (d, d), (b, a)\}$ on set $A = \{a, b, c, d\}$. Is relation R an equivalence relation. If so find equivalence classes. 6
 b) Prove the following using method of induction. 7

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

 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

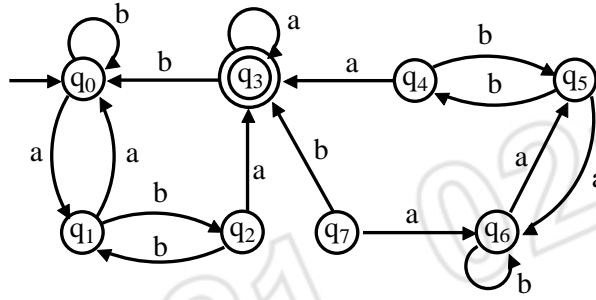
OR

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



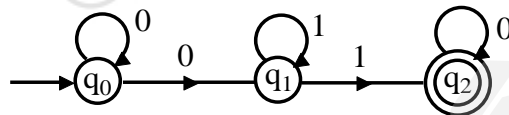
b) Minimize the following Automata.

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

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

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

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

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 $L = \{a^{2n} b^n \mid n > 0\}.$

6

b) Show that $L = \{a^n b^j \mid n \leq j^2\}$ 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
 $L = \{a^n b^n a^n b^n \mid n \geq 0\}$.

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



~ Walt Disney

