MCA 182103

Roll No. of candidate

21/3/22

2022

M.C.A .1st Semester End-Term Examination

MATHEMATICAL FOUNDATION OF COMPUTER SCIENCE

(New Regulation w.e.f. 2017-18) &

(New Syllabus w.e.f. 2018-19)

Full Marks – 70   Time – Three hours

The figures in the margin indicate full marks
for the questions.

Answer question No. 1 and any *Four* from the rest.

1. Choose the correct answer : $(10 \times 1 = 10)$

    (i) In a conjunctive statement even if one of the statements is false, then the whole conjunction becomes,

        (a) True

        (b) Negated

        (c) False

        (d) Undetermined

    (ii) If $f(x) = 3x - 1$, x is any integer number, then f is

        (a) one-to-one function

        (b) many-to-one function

        (c) onto function

        (d) into function

    (iii) If $U = \{1, 2, 3, 4, 5, 6\}$, $A = \{1, 2, 3, 4\}$, then what is the bit string of A,

        (a) 000000

        (b) 111100

        (c) 000011

        (d) 111111

(iv) Suppose $P(x): x$ is a person, $F(x): x$ is a football player. Then the statement "Some persons are football players" can be expressed symbolically as,

   (a) $\forall x\,(P(x) \Rightarrow F(x))$

   (b) $\forall x\,(P(x) \wedge F(x))$

   (c) $\exists x\,(\sim P(x) \wedge F(x))$

   (d) $\exists x\,(P(x) \Rightarrow F(x))$

(v) A regular expression for the regular set $\{ac, acc,...., bc, bcc,.....\}$ is,

   (a) $(abc)^*$

   (b) abc^*

   (c) ac^*bc^*

   (d) $(a+b)cc^*$

(vi) Which of the following is not a part of 5-tuples in finite automata?

   (a) Input alphabet

   (b) Transition function

   (c) Output alphabet

   (d) Initial State

(vii) The CFL, $L = \{a^n b^n \mid n > 0\}$ can be generated by the following CFG,

   (a) $S \rightarrow \varepsilon \mid ab \mid aSb$

   (b) $S \rightarrow ab \mid aSb$

   (c) $S \rightarrow \varepsilon \mid aSb$

   (d) None of the above

(viii) Consider the following logic program:

   food(burger).

   food(sandwich).

   food(pizza).

   lunch(sandwich).

   dinner(pizza).

   meal(X) :- food(X).

   What is the value of: meal(X), lunch(X). ?

   (a) burger

   (b) sandwich

   (c) pizza

   (d) error

(ix) Two sets A and B are said to be equal if,

    (a) $A \subset B \wedge B \subset A$

    (b) $A \subseteq B \wedge B \subseteq A$

    (c) $A \subseteq B \vee B \subseteq A$

    (d) $A \cap B \wedge B \cap A$

(x) Regular Grammar is also known as,

    (a) Type-3 grammar

    (b) Type-2 grammar

    (c) Type-1 grammar

    (d) Type-0 grammar

Answer any *four* questions from the following,

2. Consider the set A={1,2,3,4,5},

    (a) Find all the partition of the set of size 2.   (5)

    (b) Write all the subsets of the set $B = \{1,2,3\}$.   (3)

    (c) How many subsets can be constructed from the set whose number of elements is n?   (2)

    (d) Prove that $A \cup B = B \cup A$ using set theoretic notations.   (5)

3. (a) When a binary relation is called symmetric?   (3)

    (b) Let R is the relation on the set of strings of Hindi letters such that aRb if and only if $L(a)=L(b)$, where $L(x)$ is the length of the string x. Show that R is an equivalence relation.   (6)

    (c) Let $R = \{(a, b), (b, c), (c, a)\}$. Find R^{+}.   (6)

4. (a) What is the difference between a injective function and a surjective function?   (4)

    (b) Establish the equivalence $\sim (p \Leftrightarrow q) \equiv (p \wedge \sim q) \vee (\sim p \wedge q)$.   (6)

    (c) What is a proposition? Give an example. Assign truth value for the statement "$5 < 5 \vee 5 < 6$".   (5)

5. (a) Find the DFA of equivalent to $M = (\{q_0, q_1, q_2\}, \{a, b\}, \delta, q_0, \{q_2\})$. δ is given in the following transition table,   (6)

States	Σ	
	a	b
$\rightarrow q_0$	q_0, q_0	q_2
q_0	q_0	q_1
$\textcircled{$q_2$}$		q_0, q_1

(b) Define CFG and CFL. Let a grammar G represented by the following production: (6)

S→ASA|BSB|a|b

A→a

B→b

Show that the string w=aaabbbaaa $\in$ L(G)

(c) Show that if 9 books are to be kept in 4 shelves, there must be at least one shelf which contain at least 3 books. (3)
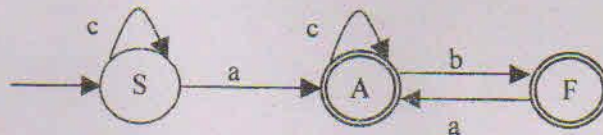
6. (a) Obtain the disjunctive normal form of : $p \lor (\sim p \Rightarrow (q \lor (q \Rightarrow \sim r)))$. (5)

(b) What is a recurrence relation? Find the first four terms of the recurrence relation $a_k = 2a_{k-1} + k$, for all integers $k \geq 2$, $a_1 = 1$. (5)

(c) Remove the ϵ-transitions from the following automata. (5)
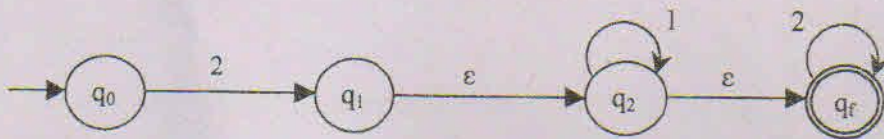
7. (a) Find the regular expression corresponding to the finite automation given below. (6)

(b) Minimize the automata as mentioned in the following transition table. (5)

States	Input	
	a	b
→ 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
ⓠ₆	q_1	q_3

(c) What is a tautology and a contradiction? Check whether $(p \lor q) \Rightarrow q$ is a tautology or not. (4)