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1012 (M3IDM)

[21-HRPD3SN-22J]

MScIT 3rd Semester (New) Exam., 2021 (W)

INTRODUCTION TO DISCRETE MATHEMATICS AND FORMAL LANGUAGES AND AUTOMATA

[MScIT S3-01]

Full Marks : 70

Time : 3 hours

The figures in the margin indicate full marks for the questions

PART—A

(Introduction to Discrete Mathematics)

(*Marks* : 35)

1. Answer any *three* from the following questions : 2×3=6

(a) Let $A = \{1, 2, 3\}$. Write down the power set of A.

(b) Define a partially ordered set with an example.

(c) Construct the truth for the statement $\sim(\sim P \vee \sim Q)$.

(d) How many different words can be formed from the letters of the word 'EXAMINATION'?

2. Answer any *three* from the following questions : 3×3=9

(a) Let Q be the set of rational numbers. Show that $*$ defined by $a * b = a + ab$ is a binary operation on Q. Examine if $*$ is *(i)* commutative and *(ii)* associative.

(b) Prove that the sum of the degrees of all the vertices of a graph is twice the number of edges.

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(c) Find the graph that have the following adjacency matrix :

$$A = \begin{pmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \end{pmatrix}$$

(d) Define a Boolean algebra and give an example.

3. Answer any *two* from the following questions : 6×2=12

(a) Let $A = \{3, 4, 5\}$, $B = \{5, 6, 7\}$. Which of the following relations are functions from A to B? If it is a function, determine whether it is one-one and whether it is onto. 2+4=6

(i) $\{(3, 5), (4, 5), (5, 7)\}$

(ii) $\{(3, 7), (4, 5), (5, 6)\}$

(iii) $\{(3, 6), (4, 6), (5, 6)\}$

(iv) $\{(3, 6), (4, 7), (5, 5)\}$

(b) Define tautology and contradiction. Using the truth table, determine whether the statement $\{(\sim P) \vee Q\} \vee \{P(-Q)\}$ is a tautology. 2+4=6

(c) Define *(i)* simple graph, *(ii)* multigraph and *(iii)* pseudograph and give an example each.

4. Answer any *one* of the following questions : 8

(a) Let $X = \{1, 2, 3\}$
Let $S = \{\{1, 2\}, \{2, 3\}, \{3, 1\}, \{1\}, \{2\}, \{3\}\}$
Let $A \leq B$ mean 'A is a subset of B' : $A, B \in S$. Show that $(S, \leq)$ is a poset. Draw a Hasse diagram of the poset. Examine if $(S, \leq)$ is a lattice.

(b) Let D_{18} be the set of positive divisors of 18. Define

$a + b$ = lcm of a, b

$a \cdot b$ = gcd of a, b

$a' = \frac{18}{a}$ for all $a, b \in D_{18}$

Examine if $(D_{18}, +, \cdot, ', 1, 18)$ is a Boolean algebra.

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PART—B

(Formal Languages and Automata)

(*Marks* : 35)

5. Answer any *two* from the following questions : 2×2=4

(a) Mention the name of two notations of representing sets with suitable examples.

(b) If the alphabet is $\Sigma = \{0, 1\}$, then find Σ^3. Mention the relationship between Kleene closure and Kleene plus.

(c) What is finite automata? Mention one application of finite automata.

6. Answer any *one* of the following questions : 3

(a) Design (draw) a DFA for the language given by L = {strings with an odd number of b's and any number of a's}. Give the exceptions of NFA with DFA.

(b) What is the role of grammar in programming language? What are the four tuples of a grammar?

7. Answer any *two* from the following questions : 6×2=12

(a) When a grammar is said to be regular grammar? Define the regular expressions of the following languages :

(i) All strings of 0's and 1's

(ii) All strings of 0's and 1's with at least two consecutive zeros

(iii) All strings of 0's and 1's not having two consecutive 1's

(iv) All strings in which any number of a's is followed by any number of b's followed by any number of c's

(v) All strings of 0's and 1's ending with 100

(b) Explain left-most and right-most derivation. For a given grammar

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

obtain the string 'aabbabab' by left most derivation.

(c) Discuss the closure properties of Context-Free Language (CFL). Write the production rules for Chomsky Normal Form (CNF). 4+2=6

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8. Answer any *two* from the following questions : 8×2=16

(a) Discuss the Chomsky classification of languages.

(b) What do you mean by ambiguity in a grammar? Show that the G with productions

$$S \to a \mid aAb \mid abSb$$
$$A \to aAAb \mid bS$$

is ambiguous. 2+6=8

(c) Define reflexive, symmetric and transitive relations with suitable example. How can you check a relation is an equivalence relation? What is an empty string?

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