STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 86
(For candidates admitted from the academic year 2023-24 & thereafter)

B.Sc. DEGREE EXAMINATION, APRIL 2026
BRANCH I - MATHEMATICS
FOURTH SEMESTER

COURSE : MAJOR CORE
PAPER : DISCRETE MATHEMATICS
SUBJECT CODE : 23MT/MC/DM43
TIME : 3 HOURS MAX. MARKS: 100

Q. No.	**SECTION A ($5 \times 2 = 10$)** **Answer ANY FIVE questions**	**CO**	**KL**
1.	State distributive laws of the algebra of proposition.	1	1
2.	Write any two properties of lattices.	1	1
3.	Define a bounded lattice.	1	1
4.	What is meant by switching algebra?	1	1
5.	Define finite state machine.	1	1
6.	Define a phrase-structure grammar.	1	1
Q. No.	**SECTION B ($10 \times 1 = 10$)** **Answer ALL questions**	**CO**	**KL**
7.	The rule $p \longrightarrow q, q \rightarrow r \vdash p \rightarrow r$ is known as_____ (a) law of syllogism (b) law of contradiction (c) law of detachment (d) De Morgan's Law	2	2
8.	The statement "For all *x* in *A*, *p*(*x*)" uses the _____quantifier. (a) existential (b) universal (c) binary (d) conditional	2	2
9.	In a lattice, the least upper bound of two elements *a* and *b* is called _____ (a) meet (b) product (c) join (d) intersection	2	2
10.	A subset *S* of a lattice *L* is called a sublattice if _____. (a) *S* is non-empty (b) *S* is closed under join and meet (c) *S* is totally ordered (d) *S* contains the least element		
11.	If a statement is true in a lattice, then its dual statement is _____. (a) always false (b) true only in distributive lattices (c) true in the dual lattice (d) true only in Boolean lattices	2	2
12.	A Boolean homomorphism is called a Boolean isomorphism if it is _____. (a) injective (b) surjective (c) bijective (d) complemented	2	2

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13.	In a Finite State Automaton, the states for which the last output was 1 are called _____ (a) initial states (b) intermediate states (c) dead states (d) accepting states	2	2
14.	In a non-deterministic finite automaton (NFA), the next-state function leads to a set of states, whereas in a deterministic finite automaton (DFA), the next-state function leads to _____. (a) no state (b) more than one state (c) a uniquely defined state (d) a final state only	2	2
15.	The Kleene closure of a language L, denoted by L^*, is _____ (a) a finite union of languages (b) the infinite union $L^0 \cup L^1 \cup L^2 \cup \cdots$ (c) the set of all substrings of L (d) the complement of L	2	2
16.	In the language $L(r)$ over A defined by a regular expression r over A, $L(r_1 + r_2)$ is defined as _____ (a) $L(r_1) \cap L(r_2)$ (b) $L(r_1)L(r_2)$ (c) $L(r_1) \cup L(r_2)$ (d) $L(r_1)^*$	2	2
Q. No.	**SECTION C ($2 \times 15 = 30$)** **Answer ANY TWO questions**	**CO**	**KL**
17.	(i) Explain universal quantifier and existential quantifier with example. (ii) Find the conjuctive normal form and disjunctive normal form for $p \leftrightarrow (\bar{p} \vee \bar{q})$ **(6 + 9)**	3	3
18.	(i) Draw the Hasse diagram for the set of all positive divisors of 12 ordered by divisibility. (ii) Prove that every chain is a distributive lattice. **(7 + 8)**	3	3
19.	Let a be any element of a Boolean algebra B. Then Prove that (i) Complement of a is unique (ii) $(a')' = a$ (iii) $0' = 1$ and $1' = 0$	3	3
20.	(i) Find the language $L(G)$ generated by the grammar G with variables $\sigma, A, B; T = \{a, b\}$ and productions $P = \{\sigma \rightarrow a\,B, B \rightarrow b, B \rightarrow bA, A \rightarrow aB\}$. (ii) State and prove pumping lemma. **(8 + 7)**	3	3

Q. No.	**SECTION D** ($\mathbf{2 \times 15 = 30}$) **Answer ANY TWO questions**	**CO**	**KL**
21.	If $(L_1, \leq)$ and $(L_2, \leq)$ are lattices then prove that $(L, \leq)$ is a lattice, where $L = L_1 \times L_2$ and the partial order $\leq$ of L is the product partial order. Hence obtain the lattice for $L_1 = \{1, 2, 4\}$ and $L_2 = \{1, 3, 9\}$ be the chain of 4 and 9 with partial order of divisible. Also draw the Hasse diagram.	4	4
22.	(i) Express $E(x, y, z) = x(y'z)'$ in its complete sum-of-products form. (ii) Show that the following Boolean expressions are equivalent to one another. Obtain their sum of product canonical form. (a) $(x + y)(x' + z)(y + z)$ (b) $(xz) + (x'y) + (yz)$ (c) $(x + y)(x' + z)$ (d) $xz + x'y$ **(6 + 9)**	4	4
23.	Draw the transition diagram of the NDFSA $M' = (\{a, b\}, \{s_0, s_1, s_2\}, s_o, f)$ where f is given by Also, find equivalent DFSA.	4	4
24.	(i) Find a context-free grammar G which generates the language $L = \{a^n b^n : n > 0\}$. (ii) Design the derivation tree for the word $a\ a\ b\ a$ in $L(G)$, where G has the productions $\sigma \to a\ A,\ A \to a\ B,\ B \to b\ B\ \ B \to a$. **(8 + 7)**	4	4
Q. No.	**SECTION E** ($\mathbf{2 \times 10 = 20}$) **Answer ANY TWO questions**	**CO**	**KL**
25.	Prove that the following argument is valid: $p \to \neg q, r \longrightarrow q, r \vdash \neg p$.	5	5
26.	Let $(L, \leq)$ be a lattice and $a, b, c \in L$. If $a \leq b \leq c$ then prove that (i) $a \vee b = b \wedge c$ and (ii) $(a \wedge b) \vee (b \wedge c) = (a \vee b) \wedge (a \vee c)$	5	5
27.	Explain OR gate, NAND gate and NOR gate	5	5
28.	Design a finite state automaton which accepts the set of all strings of 0's and 1's and containing exactly three 1's.	5	5

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I / S	a	b
s_0	φ	$\{s_1, s_2\}$
s_1	$\{s_2\}$	$\{s_0, s_1\}$
s_2	$\{s_0\}$	φ