SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

S.R.M. Nagar, Kattankulathur - 603203

DEPARTMENT OF MATHEMATICS

QUESTION BANK

III SEMESTER

Computer Science, Information Technology, Cyber Security &
Artificial Intelligence and Data Science

MA3322-DISCRETE MATHEMATICS

Regulation – 2023

Academic Year – 2025 - 2026

Prepared by

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DEPARTMENT OF MATHEMATICS

SUBJECT : MA3322-DISCRETE MATHEMATICS

SEM / YEAR: III/ II Year Common to Computer Science, Information Technology, Cyber Security and Artificial Intelligence & Data Science

UNIT I --LOGIC AND PROOFS Propositional logic – Propositional equivalences – Normal forms – Rules of inference				
Q.No.	**Question**	**BT Level**	**Competence**	**Course Outcome**
	PART – A			
1.	Construct the truth table for the compound proposition $(p \rightarrow q) \leftrightarrow (\neg p \rightarrow \neg q)$.	BTL -2	Understanding	CO 1
2.	Construct the truth table for the compound proposition $(p \rightarrow q) \rightarrow (q \rightarrow p)$.	BTL -2	Understanding	CO 1
3.	Construct the truth table for the compound proposition $(p \vee q) \rightarrow (q \wedge p)$	BTL -2	Understanding	CO 1
4.	Obtain the truth table for the compound proposition $(\neg p \leftrightarrow \neg q) \leftrightarrow (p \leftrightarrow q)$	BTL -2	Understanding	CO 1
5.	Construct the truth table and prove that $(p \rightarrow p \vee q)$ is tautology	BTL -2	Understanding	CO 1
6.	Show that the propositions $p \rightarrow q$ *and* $\neg p \vee q$ are logically equivalent.	BTL -1	Understanding	CO 1
7.	Write the symbolic of the statement “the automatic reply cannot be sent when the file system is full”	BTL -1	Remembering	CO 1
8.	State complement law of equivalence.	BTL -1	Remembering	CO 1
9.	Define tautological implication.	BTL -1	Remembering	CO 1
10.	State Distributive law.	BTL -1	Remembering	CO 1
11.	State De-Morgan’s law.	BTL -2	Understanding	CO 1
12.	What are the contrapositive, the converse and the inverse of the conditional statement “If it is raining then I get wet”.	BTL -2	Understanding	CO 1
13.	Write the symbolic representation and give its contra positive statement of “If it rains today, then I buy an umbrella”.	BTL -2	Understanding	CO 1
14.	What are the contrapositive, the converse and the inverse of the conditional statement “ If it rains heavily, then travelling will be difficult”	BTL -2	Understanding	CO 1
15.	What are the contrapositive, the converse and the inverse of the conditional statement “If you work hard then you will be rewarded”.	BTL -2	Understanding	CO 1
16.	Show that $(p \rightarrow r) \wedge (q \rightarrow r)$ *and* $(p \vee q) \rightarrow r$ are logically equivalent.	BTL -2	Understanding	CO 1
17.	Without using truth table show that $p \rightarrow (q \rightarrow p) \Leftrightarrow \neg p \rightarrow (p \rightarrow q)$.	BTL -2	Understanding	CO 1

18.	Is $\neg p \wedge (p \vee q)) \rightarrow q$ a tautology?	BTL -2	Understanding	CO 1
19.	Show that $(p \rightarrow (q \rightarrow r)) \rightarrow ((p \rightarrow q) \rightarrow (p \rightarrow r))$ is a tautology.	BTL -2	Understanding	CO 1
20.	Show that $p \longrightarrow (q \longrightarrow r) \Leftrightarrow (p \wedge q) \longrightarrow r$ without using truth table	BTL -2	Understanding	CO 1
21.	Without using truth table prove that $\neg(p \vee (\neg p \wedge q)) \Leftrightarrow (\neg p \wedge \neg q)$	BTL -2	Understanding	CO 1
22.	Discuss inference theory in short.	BTL -1	Remembering	CO 1
23.	Prove that $p, p \rightarrow q, q \rightarrow r \Rightarrow r$	BTL -2	Understanding	CO 1
24.	Prove that $p \rightarrow q, r \rightarrow \neg q, r \Rightarrow \neg p$	BTL -2	Understanding	CO 1
25.	When is a set of premises said to be inconsistent?	BTL -1	Remembering	CO 1
	PART – B			
1.(a)	Prove that $((p \vee q) \wedge \neg(\neg p \wedge (\neg q \vee \neg r))) \vee (\neg p \wedge \neg q) \vee (\neg p \wedge \neg r)$ is a tautology	BTL -3	Applying	CO 1
1.(b)	Prove that $(P \longrightarrow Q) \wedge (R \longrightarrow Q) \Leftrightarrow (P \vee R) \longrightarrow Q)$	BTL -3	Applying	CO 1
2.(a)	Without using truth table Show that $q \vee (p \wedge \neg q) \vee (\neg p \wedge \neg q)$is a tautology.	BTL -4	Analyzing	CO 1
2.(b)	Without constructing the truth tables, obtain the principle disjunctive normal form of $(\neg p \rightarrow r) \wedge (q \leftrightarrow r)$	BTL -3	Applying	CO 1
3.	Without using truth table find PCNF and PDNF of $[P \longrightarrow (Q \wedge R)] \wedge [\neg P \rightarrow (\neg Q \wedge \neg R)]$.	BTL -4	Analyzing	CO 1
4.(a)	Test the validity of the following argument, If an integer is divisible by 10 then it is divisible by 2.If an integer is divisible by 2, then it is divisible by 3.Therefore the integer divisible by 10 is also divisible by 3.	BTL -3	Applying	CO 1
4.(b)	Without using truth table Show that $q \vee (p \wedge \neg q) \vee (\neg p \wedge \neg q)$is a tautology	BTL -4	Analyzing	CO 1
5.	Obtain the PDNF and PCNF of $(P \wedge Q) \vee (\neg P \wedge R)$	BTL -4	Analyzing	CO 1
6.(a)	Show that $(\neg P \wedge (\neg Q \wedge R)) \vee (Q \wedge R) \vee (P \wedge R) \Leftrightarrow R$ without using truth table.	BTL -3	Applying	CO 1
6.(b)	Find the priciple disjucntive normal form of $(P \longrightarrow Q) \wedge (P \leftrightarrow R)$	BTL -3	Applying	CO 1
7.(a)	Obtain the PDNF and PCNF of $(\neg P \longrightarrow R) \wedge (Q \leftrightarrow P)$	BTL -4	Analyzing	CO 1
7.(b)	If there was a ball game, then travelling was difficult. If they arrived on time, then travelling was not difficult. They arrived on time. Therefore, there was no ball game". Show that these statements constitute a valid argument.	BTL -4	Analyzing	CO 1
8.	Show that R ∨ S is a valid conclusion from the premises $C \vee D, C \vee D \rightarrow \neg H, \neg H \rightarrow (A \wedge \neg B)and(A \wedge \neg B) \rightarrow (R \vee S)$	BTL -3	Applying	CO 1
9.	Show that $(p \rightarrow q), (r \rightarrow s), (q \rightarrow t), (s \rightarrow u), \neg(t \wedge u), (p \rightarrow r) \Rightarrow \neg p$	BTL -4	Analyzing	CO 1
10.	Using indirect method, show that $R \rightarrow \neg Q, R \vee S, S \rightarrow \neg Q, P \rightarrow Q \Rightarrow \neg P$	BTL -3	Applying	CO 1
11.(a)	Show that $R \wedge (P \vee Q)$is a valid conclusion from the premises $P \vee Q, Q \rightarrow R, P \rightarrow M, \neg M$	BTL -4	Analyzing	CO 1
11.(b)	Use the rules of inference to show that the hypothesis "If it does rain or if it is not foggy, then the sailing race will be held and the	BTL -4	Analyzing	CO 1

	lifesaving demonstration will go on", If the sailing race us held, then the trophy will be awarded", and "The trophy was awarded" imply the conclusion "It rained".			
12.	Show that the hypothesis, "It is not sunny this afternoon and it is colder than yesterday". "We will go swimming only if it is sunny", "If do not go swimming then we will take a canoe trip" and "If we take a canoe trip, and then we will be home by sunset". Lead to the conclusion "we will be home by sunset".	BTL -3	Applying	CO 1
13.	If the music party could not play music or the refreshments were not delivered on time, then the New year's party would have been cancelled and the organizer Ramu would have been angry. If the party were cancelled if the refunds would have to made. No refunds were made. Therefore the music party could play music.	BTL -4	Analyzing	CO 1
14.	Construct an argument to show that the following premises imply the conclusion "It rained". "If it does not rain or if there is no traffic dislocation, then the sports day will be held and the cultural Programme will go on". " If the sports day is held , the trophy will be awarded" and " the trophy was not awarded"	BTL -3	Applying	CO 1
15.(a)	Prove that the premises $P \to Q, Q \to R, S \to \neg R$ and $P \wedge S$ are inconsistent	BTL -4	Analyzing	CO 1
15.(b)	Show that $r \to s$ can be derived from the premises $p \to (q \to s), \neg r \vee p \; and \; q$	BTL -4	Analyzing	CO 1
16.	Show that the following premises are inconsistent. 1. If Jack misses many classes through illness, then he fails high school. 2. If Jack fails high school, he is uneducated 3. If Jack reads a lot of books, then he is not uneducated. 4. Jack misses many classes through illness, and reads a lot of books.	BTL -4	Analyzing	CO 1
17.	Show that the following set of premises is inconsistent: If Rama gets his degree, he will go for a job. If he goes for a job, he will get married soon. If he goes for higher study, he will not get married. Rama gets his degree and goes for higher study.	BTL -4	Analyzing	CO 1
18.(a)	Using indirect method of proof, derive $P \longrightarrow \neg S$ from the premises $P \longrightarrow (Q \vee R),\; Q \to \neg P, S \to \neg R \; and \; P.$	BTL -3	Applying	CO 1
18.(b)	Show that the premises $R \longrightarrow \neg Q, R \vee S,\; S \longrightarrow \neg Q,\; P \longrightarrow Q, P$ are inconsistent.	BTL -3	Applying	CO 1

UNIT II - COMBINATORICS

Mathematical induction – Strong induction and well ordering – The basics of counting – The pigeonhole principle – Permutations and combinations – Inclusion and exclusion principle and its applications.

Q.No.	Question	BT Level	Competence	Course Outcome
	PART – A			
1.	State the Principle of Mathematical Induction.	BTL -1	Remembering	CO 2
2.	Prove that $1+2+3+\cdots+n=\frac{n(n+1)}{2}$ using Mathematical Induction.	BTL -1	Remembering	CO 2
3.	Prove that $1+3+5+\cdots+(2n-1)=n^2,\ \ for\ n\geq 1$.	BTL -1	Remembering	CO 2
4.	Use mathematical Induction to prove that n^2-1 is divisible by 8 whenever n is an odd positive integer	BTL -2	Understanding	CO 2
5.	How many permutations are there in the word MISSISSIPPI?	BTL -2	Understanding	CO 2
6	In how many ways can all the letters in PHOTOGRAPH be arranged?	BTL -2	Understanding	CO 2
7.	How many permutations of $\{a,b,c,d,e,f,g\}$ starting with a?	BTL -2	Understanding	CO 2
8	How many different bit strings are there of length seven?	BTL -2	Understanding	CO 2
9.	How many permutations are there in the word MALAYALAM?	BTL -1	Remembering	CO 2
10	How many 7 digit numbers can be formed using the digits 1, 2, 0,2,4,2 and 4?	BTL -2	Understanding	CO 2
11.	State the Pigeonhole principle.	BTL -1	Remembering	CO 2
12.	State Generalized Pigeonhole Principle.	BTL -2	Understanding	CO 2
13.	How many cards must be selected from a deck of 52 cards to guarantee that at least 3 cards of the same suit are chosen?	BTL -1	Remembering	CO 2
14.	How many 16-bit strings are there containing exactly 5 zeros?	BTL -2	Understanding	CO 2
15.	From 10 programmers, in how many ways can five be selected when a particular programmer is included every time?	BTL -2	Understanding	CO 2
16.	Among 200 people, how many of them were born on the same month?	BTL -1	Remembering	CO 2
17.	Define Permutation.	BTL -1	Remembering	CO 2
18.	Define Combination.	BTL -2	Understanding	CO 2
19.	How many ways are there to select five players from a 10-member tennis team to make a trip to a match at another school?	BTL -1	Remembering	CO 2
20.	State the principle of Inclusion-Exclusion for two sets.	BTL -2	Understanding	CO 2
21.	State the principle of Inclusion-Exclusion for three sets.	BTL -2	Understanding	CO 2
22.	What is mathematical induction? In what way is it useful?	BTL -1	Remembering	CO 2
23.	What are the basic and inductive steps in mathematical induction?	BTL -1	Remembering	CO 2
24.	What is well ordering principle?	BTL -2	Understanding	CO 2
25.	Define circular Permutation.	BTL -1	Remembering	CO 2
	PART – B			
1.(a)	From a club consisting of six men and seven women, in how many ways we select a committee of (1) 3 men and 4 women? (2) 4 persons which has at least one woman? (3) 4 persons that has at most one man? (4) 4 persons that has both sexes?	BTL -3	Applying	CO 2

1.(b)	Using induction principles prove that $n^3 + 2n$ is divisible by 3.	BTL -3	Applying	CO 2
2.(a)	Prove by Mathematical induction, that $\frac{1}{1X2} + \frac{1}{2X3} + \frac{1}{3X4} + \cdots + \frac{1}{n(n+1)} = \frac{n}{n+1}$.	BTL -4	Analyzing	CO 2
2.(b)	How many permutations can be made out of the letters of the word “BASIC”? How many of those (1) Begin with B? (2) End with C? (3) B and C occupy the end places?	BTL -4	Analyzing	CO 2
3.(a)	Use mathematical Induction to prove that $1^2 + 3^2 + 5^2 + \cdots + (2n+1)^2 = \frac{(n+1)(2n+1)(2n+3)}{3}$, whenever n is a positive integer.	BTL -3	Applying	CO 2
3.(b)	Find the number of integers between 1 to 100 that are not divisible by any of the integers 2, 3, 5 or 7.	BTL -4	Analyzing	CO 2
4.(a)	Use mathematical induction to show that $n^2 - 1$ is divisible by 8 whenever n is an odd positive integer.	BTL -3	Applying	CO 2
4.(b)	There are three piles of identical red, blue and green balls, where each piles contains at least 10 balls. In how many ways can 10 balls be selected (1) If there is no restriction? (2) If at least 1 red ball must be selected? (3) If at least 1 red, at least 2 blue and at least 3green balls must be selected? (4) If at most 1 red ball is selected?	BTL -4	Analyzing	CO 2
5. (a)	Use mathematical induction to show that $\frac{1}{\sqrt{1}} + \frac{1}{\sqrt{2}} + \cdots + \frac{1}{\sqrt{n}} > \sqrt{n}, \quad n \geq 2$	BTL -3	Applying	CO 2
5.(b)	A Committee of 5 is to be selected from 6 boys and 5 girls. Determine the number of ways of selecting the committee if it is to consist of at least 1 boy and 1 girl.	BTL -4	Analyzing	CO 2
6.(a)	Prove by mathematical induction that $8^n - 3^n$ is divisible by 5, for each positive integer n.	BTL -3	Applying	CO 2
6.(b)	Prove that in a group of six people at least three must be mutual friends or at least three must be mutual strangers.	BTL -3	Applying	CO 2
7.(a)	If we select ten points in the interior of an equilateral triangle of side 1, show that there must be at least two points whose distance apart less than $1/3$.	BTL -4	Analyzing	CO 2
7.(b)	Using mathematical induction prove that if n is a positive integer, then 133 divides $11^{n+1} + 12^{2n-1}$	BTL -4	Analyzing	CO 2
8.(a)	Prove by induction $13^n - 6^n$ is divisible by 7.	BTL -4	Analyzing	CO 2
8.(b)	Triangle ACE is equilateral with AC=1. If five points are selected from the interior of the triangle, there are at least two whose distance apart is less than ½.	BTL -4	Analyzing	CO 2
9.(a)	A survey of 100 students with respect to their choice of the ice cream flavors Vanilla , Chocolate and Strawberry shows that 50 students like vanilla , 43 like Chocolate , 28 like strawberry ,13 like Vanilla and Chocolate, 11 like Chocolate and strawberry , 12 like Strawberry and Vanilla and5 like all	BTL -4	Analyzing	CO 2

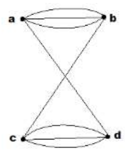
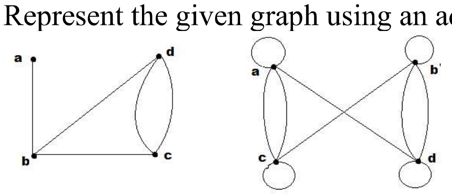
	of them . Find the number of students who like (i) Vanilla only , (ii) Chocolate (iii) Strawberry only (iv) Chocolate and strawberry but not vanilla			
9.(b)	Suppose a department consisits of eight men and women, In how many ways can we select a committee of (i) Three men and four women? (ii) Four persons that has atleast one woman? (iii) Four persons that has at most one man? (iv)Four persons that has persons of both genders?	BTL -4	Analyzing	CO 2
10.(a)	Prove by mathematical induction $\sum_{i=1}^{n} i^2 = \frac{n(n+1)(2n+1)}{6}$	BTL -3	Applying	CO 2
10.(b)	In a survey of 100 students, it was found that 40 studied Mathematics, 64 studied Physics, 35 studied Chemistry, 1 studied all the three subjects, 25 studied Mathematics and Physics, 3 studied Mathematics and Chemistry, 20 studied Physics and Chemistry. Use the principal of inclusion and exclusion, find the number of students who studied Chemistry only and the number who studied none of these subjects.	BTL -3	Applying	CO 2
11.	(a) Assuming that repetitions are not permitted, how many four digit numbers can be formed from the 6 digits 1, 2, 3,5,7,8? (b) How many of these numbers are less than 4000? (c) How many of the numbers in (a) are even? (d) How many of the numbers in (a) are odd? (e) How many of the numbers in (a) are multiples of 5?	BTL -4	Analyzing	CO 2
12.(a)	40 computer programmers interviewed for a job. 25 knew JAVA, 28 knew ORACLE and 7 knew neither language. How many knew both languages?	BTL -3	Applying	CO 2
12.(b)	In a class of 50 students, 20 students play football, and 16 students play hockey. It is found that 10 students play both the games. Find the number of students who play neither? 0	BTL -3	Applying	CO 2
13.(a)	A total of 1232 students have taken a course in Spanish, 879 have taken a course in French and 114 have taken a course in Russian. Further 103 have taken courses in both Spanish and French, 23 have taken courses in both Spanish and Russian and 14 have taken courses in both French and Russian. If 2092 students have taken at least one Spanish, French and Russian, how students have taken a course in all three languages?	BTL -4	Analyzing	CO 2
13.(b)	How many positive integers not exceeding 1000 are divisible by none of 3,7 and 11?	BTL -4	Analyzing	CO 2
14.	Determine the number of positive integer n, $1 \leq n \leq 2000$ that are not divisible by 2, 3 or 5 but are divisible by 7.	BTL -3	Applying	CO 2
15.	During a four-week vacation, a school student will attend at least one computer class each day, but he won't attend more than 40 classes in all during the vacation. Prove that no matter how he distributes his classes during the four weeks, there is a consecutive span of days which he will attend exactly 15 classes?	BTL -4	Analyzing	CO 2

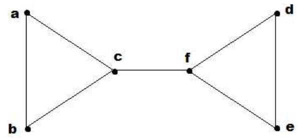
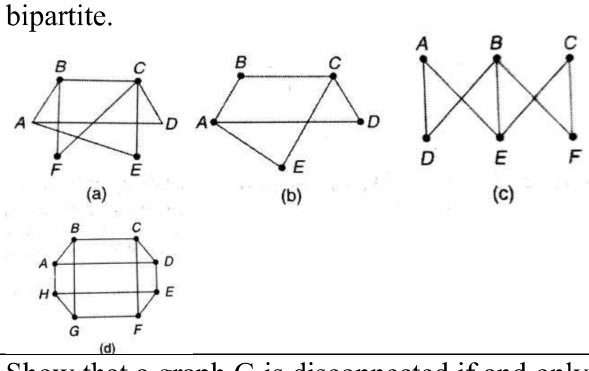
16.	How many bits of string of length 10 contain (i)Exactly four 1's (ii)At most four 1's (iii)At least four 1's (iv)An equal number of 0's and 1's	BTL -4	Analyzing	CO 2
17.	A survey of 550 television watchers produced the following information: 285 watch football game, 195 watch hockey game, 115 watch baseball game, 45 watch football and baseball games, 70 watch football and hockey games, 50 watch hockey and baseball games, 100 do not watch any of the three games. Then (a) How many people in the survey watch all three games? (b) How many people watch exactly one of the three games?	BTL -4	Analyzing	CO 2
18.(a)	Find the number of integers between 1 to 250 that are not divisible by any of the integers 2,3,5 and 7	BTL -3	Applying	CO 2
18.(b)	In a survey of 120 passengers, an Airline found that 52 enjoyed wine with their meals, 75 enjoyed mixed drinks and 62 enjoyed iced tea. 35 enjoyed any given pair these beverages and 20 passengers enjoyed all of them. Find the no. of passengers who enjoyed (i) Only tea (ii) Only one of the three (iii) Exactly two of the three beverages (iv) None of the drinks	BTL -3	Applying	CO 2

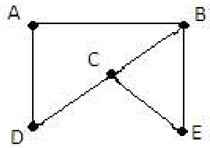
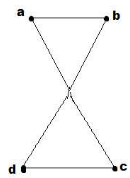
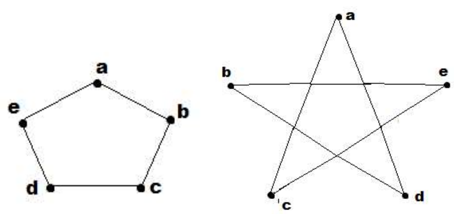
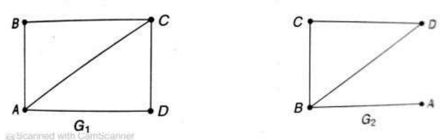
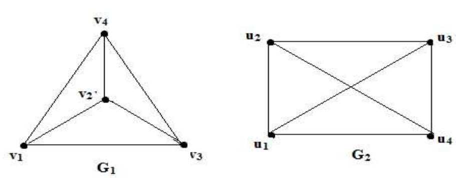
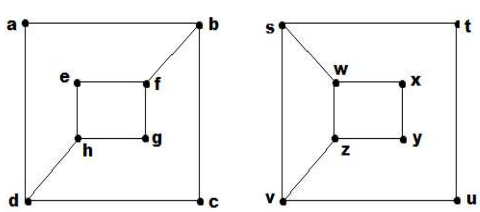
UNIT III – Graph Theory

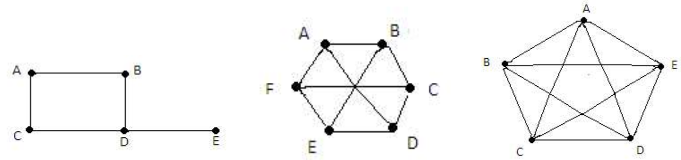
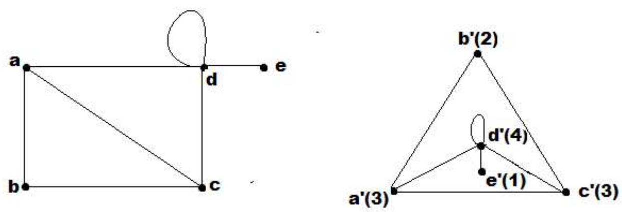
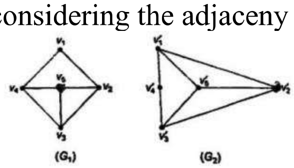
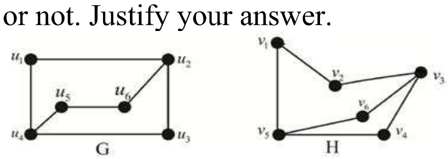
Graphs and graph models – Graph terminology and special types of graphs – Matrix representation of graphs and graph isomorphism – Connectivity – Euler and Hamilton Graphs Definition

Q.No.	Question	BT Level	Competence	Course Outcome
	PART – A			
1.	Define complete graph and draw K_5.	BTL -1	Remembering	CO 3
2.	Define a regular graph. Can a complete graph be a regular graph?	BTL -1	Remembering	CO 3
3.	Define pseudo graphs	BTL -1	Remembering	CO 3
4.	Draw the graph with the following adjacency matrix $\begin{pmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{pmatrix}$	BTL -2	Understanding	CO 3
5.	State the handshaking theorem.	BTL -1	Remembering	CO 3
6	There are 25 telephones in Geeks land. Is it possible to connect them with wires so that each telephone is connected with exactly 7 others.	BTL -2	Understanding	CO 3
7.	When is a simple graph G bipartite? Give an example.	BTL -2	Understanding	CO 3

8	How many edges are there in a graph with 10 vertices each of degree 3?	BTL -2	Understanding	CO 3
9.	How many edges does a graph have if it has vertices of degree 5, 2, 2, 2, 2, 1? Draw such a graph.	BTL -2	Understanding	CO 3
10	Define connected graph and a disconnected graph with example.	BTL -1	Remembering	CO 3
11.	Let G be the graph with 10 vertices. If four vertices has degree four and six vertices has degree five , then find the number of edges of G.	BTL -2	Understanding	CO 3
12.	Use an incidence matrix to represent the graph.  	BTL -2	Understanding	CO 3
13.	Draw the graph with the following adjacency matrix $\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$	BTL -2	Understanding	CO 3
14.	Give an Example of a bipartite graph which is Hamiltonian but not Eulerian.	BTL -2	Understanding	CO 3
15.	What should be the degree of each vertex of a graph G if it has Hamilton circuit?	BTL -2	Understanding	CO 3
16.	Define complete bipartite graph.	BTL -1	Remembering	CO 3
17.	State the necessary and sufficient conditions for the existence of an Eulerian path in a connected graph.	BTL -1	Remembering	CO 3
18.	Define Hamiltonian path.	BTL -2	Understanding	CO 3
19.	Show that there does not exist a graph with 5 vertices with degrees 1, 3, 4, 2, 3 respectively.	BTL -1	Remembering	CO 3
20.	Give an example of a graph which is Eulerian but not Hamiltonian	BTL -1	Remembering	CO 3
21.	For which value of m and n does the complete bipartite graph $K_{m\,n}$, have an (i) Euler circuit (ii) Hamilton circuit.	BTL -1	Remembering	CO 3
22.	Represent the given graph using an adjacency matrix.  	BTL -1	Remembering	CO 3
23.	An undirected graph G has 16 edges and all the vertices are of degree 2. Find the number of vertices.	BTL -1	Remembering	CO 3
24.	For which values of n do the graphs K_n and C_n have an Euler path but no Euler circuit?	BTL -1	Remembering	CO 3
25.	Does the graph have a Hamilton path? If so find such a path.	BTL -1	Remembering	CO 3

				
	PART – B			
1.	Prove that the maximum number of edges in a simple disconnected graph G with n vertices and k components is $(n-k)(n-k-1)/2$	BTL -3	Applying	CO 3
2.(a)	The sum of all vertex degree is equal to twice the number of edges (or) the sum of the degrees of the vertices of G is even.	BTL -4	Analyzing	CO 3
2.(b)	Let $\delta(G) and \bigtriangleup(G)$ denotes minimum and maximum degrees of all the vertices of G respectively. Then show that for a non-directed graph G, $\delta(G) \le \frac{2\lvert E\rvert}{\lvert V\rvert} \le \bigtriangleup(G)$	BTL -3	Applying	CO 3
3.(a)	For any simple graph$G$, the number of edges of G is less than or equal to $\frac{n(n-1)}{2}$, where n is the number of vertices in G.	BTL -4	Analyzing	CO 3
3.(b)	Prove that the complement of a disconnected graph is connected.	BTL -4	Analyzing	CO 3
4.	Explain Konigsberg Bridge Problem. Represent by means of graph. Does the problem have a solution?	BTL -3	Applying	CO 3
5.(a)	If a graph G has exactly two vertices of odd degree there is a path joining these two vertices.	BTL -3	Applying	CO 3
5.(b)	Write the adjacency matrix of the digraph $G = \left\{\begin{matrix} (v_1,v_3),(v_1,v_2),(v_2,v_4), \\ (v_3,v_1),(v_2,v_3),(v_3,v_4), \\ (v_4,v_1),(v_4,v_2),(v_4,v_3) \end{matrix}\right\}$. Also draw the graph.	BTL -3	Applying	CO 3
6.(a)	Define (i) Complete graph. (ii) Complete bipartite graph with example.	BTL -4	Analyzing	CO 3
6.(b)	Determine the number of path of length n between two different vertices in K_4 if n is (i) 2 (ii) 3 (iii)4	BTL -3	Applying	CO 3
7.	Discuss which of the following graphs are bipartite and which are not. If a graph is bipartite, state if it is completely bipartite. 	BTL -3	Applying	CO 3
8.(a)	Show that a graph G is disconnected if and only if its vertex set V can be partitioned into two non-empty subsets V_1 and V_2 such that there exist no edge in G whose one end vertex is in V_1 and the other is V_2 .	BTL -4	Analyzing	CO 3

8.(b)	Find the number of paths of length 4 from the vertex D to E in the undirected graph given below. 	BTL -3	Applying	CO 3
9.(a)	How many paths of length four are there from a to d in the simple graph G given below. 	BTL -3	Applying	CO 3
9.(b)	Represent each of the following graphs with an adjacency matrix(i) K_4 (ii) $K_{1,4}$ $(iii)C_4$ (iv) W_4.	BTL -4	Analyzing	CO 3
10.(a)	Using adjacency matrix examine whether the following pairs of graphs G and G^1 given below are isomorphism or not. 	BTL -4	Analyzing	CO 3
10.(b)	Find Hamilton path and Hamilton cycles if it exists in each of the graphs given below 	BTL -4	Analyzing	CO 3
11.	Define isomorphism. Establish an isomorphism for the following the graphs. 	BTL -4	Analyzing	CO 3
12.	Show that the following graphs G and H are not isomorphic. 	BTL -3	Applying	CO 3
13.	Find an Euler path or an Euler Circuit if it exists, in each of the three graphs given below.	BTL -3	Applying	CO 3

				
14.(a)	The adjacency matrices of two pairs of graph as given below. Examine the isomorphism of G and H by finding a permutation matrix. $A_G = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}, A_H = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix}$	BTL -4	Analyzing	CO 3
14.(b)	If G is a graph with n vertices and $(G) \geq \frac{n-1}{2}$, then G is connected.	BTL -4	Analyzing	CO 3
15.	Show that the following graphs are isomorphic. 	BTL -4	Analyzing	CO 3
16.	Establish the isomorphism of the following graphs by considering the adjaceny matrices  Or	BTL -4	Analyzing	CO 3
17.	Examine whether the following pair of graphs are isomorphic or not. Justify your answer. 	BTL -4	Analyzing	CO 3
18.	Give an example of a graph which is (i) Eulerian but not Hamiltonian (ii) Hamiltonian but not Eulerian (iii) Both Eulerian and Hamiltonian (iv) Not Eulerian and not Hamiltonian	BTL -4	Analyzing	CO 3

UNIT IV - GROUP THEORY

Algebraic systems - Groups – Subgroups – Homomorphisms –Subgroups – Lagrange‘s theorem

Q.No.	Question	BT Level	Competence	Course Outcome
	PART – A			
1.	Define monoid. Give an example of monoid.	BTL -1	Remembering	CO 4
2.	Show that semi-group homomorphism preserves the property of idempotency.	BTL -1	Remembering	CO 4

3.	Find the idempotent elements of $G = \{1, -1, i, -i\}$ under the binary operation multiplication	BTL -1	Remembering	CO 4
4.	Let (R-{1}, *) be the set of real numbers and * is the binary operation defined as $a * b = a + a + ab, for\ a, b \in R - \{1\}$. Find the identity element.	BTL -2	Understanding	CO 4
5.	Define group and State any two properties of a group.	BTL -1	Remembering	CO 4
6	Let R be the set of non-zero real numbers and * is the binary operation defined as $a * b = \frac{ab}{2}, for\ a, b \in R$. Find the inverse of any element	BTL -2	Understanding	CO 4
7.	Prove that identity element in a group is unique.	BTL -2	Understanding	CO 4
8	Prove that the inverse of each element of the group $(G,*)$is unique	BTL -2	Understanding	CO 4
9.	Show that the cancellation laws are true in a group $(G,*)$	BTL -2	Understanding	CO 4
10	If $(G,*)$ is a group infer that the only idempotent element of a is the identity element	BTL -2	Understanding	CO 4
11.	Prove if a has inverse b and b has inverse c, then a = c .	BTL -2	Understanding	CO 4
12.	Define a cyclic group and give an example	BTL -1	Remembering	CO 4
13.	In a group $(G,*), prove\ that\ (a * b)^{-1} = b^{-1} * a^{-1}$for all $a, b \in G$	BTL -2	Understanding	CO 4
14.	Let Z be a group of integers with binary operation * defined by $a * b = a + b - 2$ for all $a, b \in Z$. Find the identity element of the group$\langle Z,*\rangle$.	BTL -2	Understanding	CO 4
15.	Define normal subgroup.	BTL -1	Remembering	CO 4
16.	Prove that if G is abelian group, then for all $a, b \in G, (a * b)^2 = a^2 * b^2$	BTL -1	Remembering	CO 4
17.	Prove that every cyclic group is abelian	BTL -1	Remembering	CO 4
18.	Show that $(Z_5, +_5)$ is a cyclic group.	BTL -1	Remembering	CO 4
19.	Is $(Z_5^*,\times_6)$ a cyclic group.Justify	BTL -2	Understanding	CO 4
20.	If $a$is a generator of a cyclic group$G$, then show that a^{-1} is also a generator of$G$.	BTL -2	Understanding	CO 4
21.	State Lagrange's theorem.	BTL -2	Understanding	CO 4
22.	Find the left cosets of {[0], [3]} in the addition modulo group $(Z_6, +_6)$.	BTL -2	Understanding	CO 4
23.	Define Homomorphism	BTL -1	Remembering	CO 4
24.	Define Semi group. Give an example.	BTL -1	Remembering	CO 4
25.	Define left and right coset of subgroup	BTL -2	Understanding	CO 4
	PART – B			

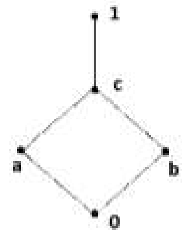
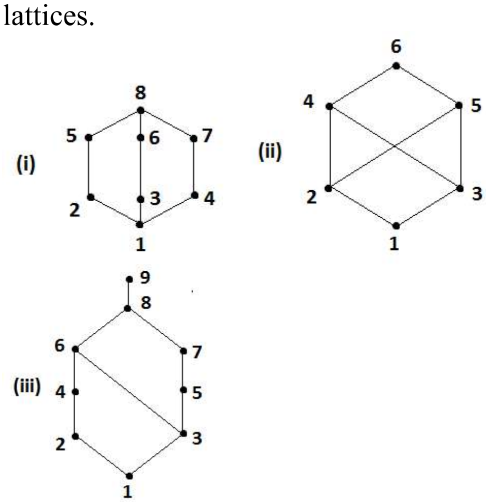
1.	If $S = NXN$, the set of ordered pairs of positive integers with the operation $*$ defined by $(a, b) * (c, d) = (ad + bc,\ bd)$ and if $f: (S,*) \rightarrow (Q, +)$is defined by $f(a, b) = a/b$, show that f is a semi group homomorphism.	BTL -3	Applying	CO 4
2.(a)	Prove that in a group G the equations $a * x = b\ and\ y * a = b$ have unique solutions for the unknowns x and y as $x = a^{-1} * b, y = b * a^{-1}$when$a, b \in G$.	BTL -4	Analyzing	CO 4
2.(b)	Evaluate that the set of all matrices $\begin{bmatrix} a & b \\ -b & a \end{bmatrix}$forms an abelian group with respect to matrix multiplication.	BTL -4	Analyzing	CO 4
3.	Prove that $G = \left\{\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}, \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}, \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}\right\}$ forms an abelian group under matrix multiplication.	BTL -3	Applying	CO 4
4.(a)	If $(G,*)$ is an abelian group and if $\forall\ a, b\ \in G$. Show that $(a * b)^n = a^n * b^{\,n}, for\ every\ integer\ n$	BTL -3	Applying	CO 4
4.(b)	Let (R-{1}, *) be the set of real numbers and * is the binary operation defined as $a * b = a + a + ab, for\ a, b \in R - \{1\}$. Show that $(R - \{1\})$.is an abelian group	BTL -3	Applying	CO 4
5.	Apply the definition of a group to Prove that $(G,*)$ is a non-abelian group where $G = R^* \times R$ and the binary operation * is defined as $(a, b) * (c, d) = (ac, bc + d)$	BTL -4	Analyzing	CO 4
6.	Show that group homomorphism preserves identity, inverse, and subgroup	BTL -3	Applying	CO 4
7.	Show that M_2, the set of all $2X2$ nonsingular matrices over R is a group under usual matrix multiplication. Is it abelian?	BTL -4	Analyzing	CO 4
8.(a)	Prove that the intersection of two subgroups of a group G is again a subgroup of G	BTL -4	Analyzing	CO 4
8.(b)	Prove that the set $\{1, -1, i, -i\}$ is a finite abelian group with respect to the multiplication of complex numbers.	BTL -3	Applying	CO 4
9.	Determine whether $H_1 = \{0, 5, 10\}\ and\ H_2 = \{0, 4, 8, 12\}$are subgroups of Z_{15}.	BTL -3	Applying	CO 4
10.(a)	Prove that the necessary and sufficient condition for a non-empty subset H of a group $(G,*)$to be a subgroup is $a, b \in H \Rightarrow a * b^{-1} \in H$	BTL -4	Analyzing	CO 4
10.(b)	Prove that, R the set of non-zero real numbers and * is the binary operation defined as $a * b = \frac{ab}{2}, for\ a, b \in R$ is an abelian group	BTL -3	Applying	CO 4
11.	Prove that$(S_3,*)$,where $S = (1,2,3)$ is a group under the operation of right composition. Is it abelian?	BTL -4	Analyzing	CO 4
12.	Prove that the kernel of a homomorphism f from a group $(G,*)$ to a group (T, Δ) is a subgroup $(G,*)$	BTL -3	Applying	CO 4
13.	If (G, *) is a finite cyclic group generated by an element $a \epsilon G$ and is of order n then $a^n = e$ so that $G = \{a, a^2, \ldots\ \ a^n(= e)\}$. Also, n is the least positive integer for which $a^n = e$.	BTL -4	Analyzing	CO 4
14.(a)	Let G be a group and $a \in G$. Let $f: G \rightarrow G$ be given by	BTL -3	Applying	CO 4

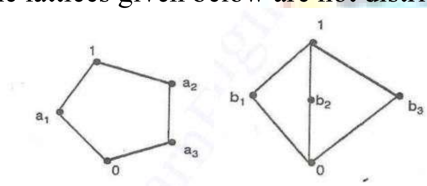
	$f(x) = axa^{-1}, \forall\, x \in G$. Prove that f is an isomorphism of G onto G			
14.(b)	Show that the group $(\{1, 2, 3, 4\}, X_5)$ is cyclic.	BTL -3	Applying	CO 4
15.	Find all the subgroups pf $(Z_9, +_9)$	BTL -4	Analyzing	CO 4
16.(a)	Show that G= {1, 3, 7, 9} is an abelian group under multiplication modulo 10.	BTL -4	Analyzing	CO 4
16.(b)	Let $(H, \cdot)$be a subgroup of $(G, \cdot)$ and let $N = \{x \,/ x \in G, xHx^{-1} = H\}$. Show that $(N, \cdot)$is a subgroup of G.	BTL -3	Applying	CO 4
17.	State and Prove Lagrange's Theorem.	BTL -4	Analyzing	CO 4
18.(a)	Prove that $(U_9, \times_9)$ is an abelian group	BTL -3	Applying	CO 4
18.(b)	Let $H = \{[0], [4], [8]\}$ is a subgroup of $(Z_{12}, +_{12})$, find all the cosets of H	BTL -3	Applying	CO 4

UNIT V - LATTICES AND BOOLEAN ALGEBRA

Partial ordering – Posets – Lattices as posets – Properties of lattices - Some special lattices – Boolean algebra.

Q.No.	Question	BT Level	Competence	Course Outcome
	PART – A			
1.	Define partial order relation	BTL -1	Remembering	CO 5
2.	Let X={ 2,3,6,12,24,36} and the relation $\leq$ be such that $x \leq y$ if x divides y. Draw the Hasse diagram of $(x, \leq)$	BTL -1	Remembering	CO 5
3.	Draw the Hasse diagram for $[S, \,/\,]$ where $S = \{1,2,3,4,5,7,8,12\}$	BTL -2	Understanding	CO 5
4.	Draw the Hasse diagram for $[P(A), \subseteq]$ where $A = \{1,2,3\}$	BTL -2	Understanding	CO 5
5.	Write Absorption law of Lattice.	BTL -2	Understanding	CO 5
6	Define Least upper bound and Greatest lower bound.	BTL -1	Remembering	CO 5
7.	Define Lattice with example.	BTL -1	Remembering	CO 5
8	Show that ({1, 2, 3, 4, 5}, /) is not a lattice.	BTL -2	Understanding	CO 5
9.	Define Lattice Homomorphism	BTL -1	Remembering	CO 5
10	Define Distributive lattice	BTL -1	Remembering	CO 5
11.	Give an example of a lattice which is not distributive.	BTL -2	Understanding	CO 5
12.	Define Complemented Lattice.	BTL -1	Remembering	CO 5
13.	Define Modular Lattice.	BTL -1	Remembering	CO 5
14.	Prove that every distributive lattice is Modular.	BTL -2	Understanding	CO 5
15.	State the reason to the statement "Every Chain is Modular".	BTL -2	Understanding	CO 5

16.	Show that the following lattice is not complemented. 	BTL -1	Remembering	CO 5
17.	Draw the Hasse diagram for $P_1 = \{2,3,6,12,24\}$ and $P_2\{1,2,3,4,6,12\}$and $\leq$ is a relation such $x \leq y$ if and only if $x\ divides\ y$	BTL -2	Understanding	CO 5
18.	Define Boolean Algebra	BTL -1	Remembering	CO 5
19.	What is the 0 element and unity element of $[D_{30},\ /\ ]$.	BTL -2	Understanding	CO 5
20.	State the dual of $a \wedge (b \vee c) = (a \wedge b) \vee (a \wedge c)$	BTL -2	Understanding	CO 5
21.	Define Sub-lattice.	BTL -1	Remembering	CO 5
22.	When is a lattice said to be bounded?	BTL -2	Understanding	CO 5
23.	Give an example of a distributive lattice but not complemented.	BTL -2	Understanding	CO 5
24.	Define Sub Boolean Algebra.	BTL -1	Remembering	CO 5
25.	In there a Boolean algebra with five elements? Justify.	BTL -2	Understanding	CO 5
	PART – B			
1.(a)	Let N be set of all natural numbers. Prove that the relation R in N defined by $aRb \Leftrightarrow a\ divides\ b$ is a partial order relation.	BTL -3	Applying	CO 5
1. (b)	Determine which of the following Hasse diagrams are lattices. 	BTL -3	Applying	CO 5
2.	State and Prove Idempotent property, Commutative property and Associative property of lattice.	BTL -4	Analyzing	CO 5

3.(a)	Let (L,≤) be a Lattice, then prove that for $a, b \in L,\ a \le b \Leftrightarrow a \wedge b = a \Leftrightarrow a \vee b = b$.	BTL -4	Analyzing	CO 5
3.(b)	Prove that in a Boolean Algebra $(a \cup b)' = a' \wedge b'$ and $(a \wedge b)' = a' \vee b'$	BTL -3	Applying	CO 5
4.(a)	Let (L,≤) be a Lattice, for $a, b \in L$ then prove that $a \wedge (b \vee c) \ge (a \wedge b) \vee (a \wedge c)$ and $a \vee (b \wedge c) \le (a \vee b) \wedge (a \vee c)$	BTL -3	Applying	CO 5
4.(b)	In a complemented and distributive lattice, then prove that complement of each element is unique.	BTL -3	Applying	CO 5
5.	Show that in a complemented distributive lattice, $a \le b \Leftrightarrow a * b' = 0 \Leftrightarrow a' \oplus b = 1 \Leftrightarrow b' \le a'$	BTL -3	Applying	CO 5
6.(a)	Prove that the cancellation property: Let (L,≤) be a Lattice, for $a, b \in L$ then $a \vee b = a \vee c \;\&\; a \wedge b = a \wedge c \Rightarrow b = c$ $\forall a, b, c \in L$	BTL -3	Applying	CO 5
6.(b)	If a and b are two elements of a Boolean Algebra, prove that $a + (a.b) = a;\ a.(a + b) = a$	BTL -3	Applying	CO 5
7.	If (L, *, ⊕) be a complemented, distributive lattice then prove that for any $a, b \in L$, $(a * b)' = a' \oplus b'$ and $(a \oplus b)' = a' * b'$.	BTL -4	Analyzing	CO 5
8.(a)	Show that a chain is a lattice. Let (L,≤) be a Lattice, for $a, b, c \in L$ then $a \le c \Rightarrow a \vee (b \wedge c) \le (a \vee b) \wedge c$ (or) $a \oplus (b * c) \le (a \oplus b) * c$	BTL -4	Analyzing	CO 5
8.(b)	In a Boolean Algebra. Show that $(a + b')(b + c')(c + a') =$ $(a + b')(b + c')(c + a') = (a' + b)(b' + c)(c' + a)$	BTL -3	Applying	CO 5
9.(a)	Show that the lattices given below are not distributive 	BTL -4	Analyzing	CO 5
9.(b)	Draw the Hasse diagram for $< x, \le >$, where X= {2,4,5,10,12,20,25} and the relation ≤ be such that $x \le y$ is x divides y.	BTL -4	Analyzing	CO 5
10.(a)	Prove that every chain is a distributive lattice.	BTL -4	Analyzing	CO 5
10.(b)	In a Boolean Algebra, prove that $(a + b)' = a'.b'$ & $(a.b)' = a' + b'$	BTL -3	Applying	CO 5
11.	In a Boolean Algebra, show that the following statements are equivalent. For any a, b (i) $a + b = b$ (ii) $a.b = a$ (iii) $a' + b = 1$ (iv)$a.b' = 0$ (v) $a \le b$	BTL -4	Analyzing	CO 5
12.(a)	Show that in a Boolean Algebra, for any a and b, $a = b$ iff $(a \wedge b') \vee (a' \wedge b) = 0$ or $a = b$ iff $a.b' + a'.b = 0$.	BTL -3	Applying	CO 5
12.(b)	Prove that $D_{42} \equiv \{S_{42}, D\}$ is a complemented Lattice by finding complements of all the elements.	BTL -3	Applying	CO 5
13.	Let D_{30} = {1, 2, 3,5,6,10,15, 30} and let the relation R be divisor on D_{30}. Find 1. Draw the Hasse Diagram.	BTL -4	Analyzing	CO 5

	2. All lower bounds of 10 and 15. 3. the GLB of 10 and 15 4. all upper bounds of 10 and 15 5. LUB of 10 and 15. 6. All the sublattice which contains 4 elements.			
14.(a)	Consider the Boolean algebra D_{70}. Verify whether A= {1, 7, 10, 70} and B = {1, 2, 35, 70} are sub algebras of D_{70}	BTL -3	Applying	CO 5
14.(b)	Find all the sub lattices of $[P(S), \subseteq]$ where S = $\{p, q, r\}$	BTL -3	Applying	CO 5
15.	In a Boolean Algebra. Show that $(a + b')(b + c')(c + a') = (a' + b)(b' + c)(c' + a)$	BTL -4	Analyzing	CO 5
16.(a)	Prove that in a Boolean Algebra, $a = 0$ iff $a.b' + a'.b = b$.	BTL -4	Analyzing	CO 5
16.(b)	Show that in any Boolean Algebra, $(x + y)(x' + z) = xz + x'y$	BTL -3	Applying	CO 5
17.	Let D_{24} = {1, 2, 3, 4, 6, 8, 12, 24} and let the relation R be divisor on D_{24}. Find 1. Draw the Hasse Diagram. 2. All lower bounds of 8 and 12. 3. the GLB of 8 and 12 4. all upper bounds of 8 and 12 5. LUB of 8 and 12. 6. All the sublattice which contains 5 elements.	BTL -4	Analyzing	CO 5
18.(a)	In a Boolean Algebra, for any *a,b,c* Show that (i) $(a \wedge b \wedge c) \vee (b \wedge c) = b \wedge c$ (ii) $\left((a \vee c) \wedge (b' \wedge c)\right)' = (a' \vee b) \wedge c'$	BTL -3	Applying	CO 5
18.(b)	Find all the sub lattices of the lattice (S_{12}, D)	BTL -3	Applying	CO 5