UNITED INSTITUTE OF TECHNOLOGY

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Periyanaickenpalayam, Coimbatore – 641020

DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

QUESTION BANK

II YEAR

SEMESTER – 03

ACADEMIC YEAR: 2025 – 2026

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HEAD OF THE DEPARTMENT

ACOE **PRINCIPAL** **CHAIRMAN**

24MABS301
DISCRETE MATHEMATICS

UNIT – 1

LOGIC AND PROOFS

Propositional logic – Propositional equivalences - Predicates and quantifiers – Nested quantifiers – Rules of inference - Introduction to proofs.

Q. NO	QUESTION	CO	BTL	Marks
	PART–A			
1.	State the truth table of "If tigers have wings then the earth travels round the sun".	1	Und	2
2.	Give the converse and contra positive of the implication "If it is raining, then I get wet".	1	Und	2
3.	Show that P→Q and ¬P∨Q are equivalent.	1	Und	2
4.	Construct the truth table for the compound proposition (p →q)→(q→p).	1	Und	2
5.	Symbolize the statement "Good food is not cheap".	1	Und	2
6.	Write the following sentence in a symbolic form "Every one who is healthy can do all kinds of work".	1	Und	2
7.	Verify (R→S) ∨¬(R→S) is a tautology.	1	Und	2
8.	Verify P∨Q→P is a tautology.	1	Und	2
9.	Show that ¬ (P→Q) and P∧¬Q are equivalent.	1	Und	2
10.	What are the negations of the statements $\forall x(x^2 > x)$ *and* $\exists x(x^2 = 2)$?	1	Rem	2
11.	Construct the truth table for the compound proposition $(p \rightarrow q) \rightarrow (q \rightarrow p)$.	1	Und	2
12.	State Demorgan's laws of logic.	1	Rem	2
13.	Express the following statement using predicators and quantifiers, "All men are mortal"	1	Und	2
14.	When a set of formulae is consistent and inconsistent?	1	Rem	2
15.	Determine whether the conclusion C follows logically from the premises H_1 and H_2 or not. H_1 : P→Q, H_2 : P, C : Q	1	Und	2

PART-B

1.	(i) Construct the truth table for the following statement $\neg(p \vee (q \wedge r)) \leftrightarrow ((p \vee q) \wedge (p \vee r))$.	1	Und	8
	(ii) Show that $\big(\neg P \wedge (\neg Q \wedge R)\big) \vee (Q \wedge R) \vee (P \wedge R) \Leftrightarrow R$.	1	Und	8
2.	(i) Show that $p \vee (q \wedge r)$ *and* $(p \vee q) \wedge (p \vee r)$ are logically equivalent.	1	App	8
	(ii) Without constructing the truth table find the PDNF and PCNF of $(\neg P \rightarrow R) \wedge (Q \leftrightarrow P)$.	1	App	8
3.	(i) Without constructing the truth table find the PDNF and PCNF of $P \rightarrow (Q \wedge R) \wedge (\neg P \rightarrow (\neg Q \wedge \neg R))$	1	App	8
	(ii) Find the PDNF of the statement, $(q \vee (p \wedge r)) \wedge \neg((p \vee r) \wedge q)$.	1	App	8
4	(i) Using indirect method of proof, derive $P \rightarrow \neg S$ from $P \rightarrow (Q \vee R)$, $Q \rightarrow \neg P$, $S \rightarrow \neg R$, P.	1	App	8
	(ii) Use the indirect method to prove that the conclusion $\exists z Q(z)$ follows from the premises $\forall x(P(x) \rightarrow Q(x))$ *and* $\exists y P(y)$.	1	App	8
5	(i) Find the disjunctive normal form of $p \rightarrow ((p \rightarrow q) \wedge \neg (\neg q \vee \neg p))$.	1	Und	8
	(ii) Use indirect method of proof, $(\forall x)(P(x) \vee Q(x)) \Rightarrow (\forall x)P(x) \vee (\exists x)Q(x)$.	1	App	8
6	(i)Show that $R \rightarrow S$ can be derived from the premises $P \rightarrow (Q \rightarrow S)$, $\neg R \vee P$ and Q.	1	App	8
	(ii)Show that $R \vee S$ follows logically from the premises $C \vee D, (C \vee D) \rightarrow \neg H, \neg H \rightarrow (A \wedge \neg B)$ and $(A \wedge \neg B) \rightarrow (R \vee S)$.	1	App	8
7	(i)Without using truth tables, show that $Q \vee (P \wedge \neg Q) \vee (\neg P \wedge \neg Q)$ is a tautology.	1	App	8
	(ii)Show that S is valid inference from the premises $P \rightarrow \neg Q, Q \vee R, \neg S \rightarrow P$ and $\neg R$.	1	App	8
8	(i)Show that the premises $R \rightarrow \neg Q, R \vee S, S \rightarrow \neg Q, P \rightarrow Q, P$ are inconsistent.	1	App	8
	(ii)Show that d can be derived from the premises $(a \rightarrow b) \wedge (a \rightarrow c), \neg(b \wedge c), d \vee a$	1	App	8

UNIT – 2

COMBINATORICS

Mathematical induction – Strong induction and well ordering – The basics of counting – Thepigeonhole principle – Permutations and combinations – Recurrence relations – Solving linear recurrence relations – Inclusion and exclusion principle and its applications.

Q. NO	QUESTION	CO	BTL	Marks
	PART–A			
1.	State the principle of Mathematical induction.	2	Rem	2
2.	State the principle of Strong induction.	2	Rem	2
3.	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?	2	Und	2
4.	What is the number of arrangements of all the six letters in the word PEPPER ?	2	Und	2
5.	In how many ways can the letters of the word MISSISSIPPI be arranged?	2	Und	2
6.	Find the number of permutations of the letters of the word MATHEMATICS.	2	Und	2
7.	State the Pigeonhole principle.	2	Rem	2
8.	If 9 colours are used to paint 100 houses, show that at least 12 houses will be of the same colour.	2	Und	2
9.	If we select any group of 1000 students on campus . show that atleast 3 of them must have same birthday .	2	Und	2
10.	Define recurrence relation .	2	Rem	2
11.	Find the recurrence relation for the Fibonacci sequence	2	Und	2
12.	Find the first four terms of the sequence defined by the recurrence relation and initial condition$a_n = a_{n-1}^2$, $a_1 = 2$.	2	Und	2
13.	Find the recurrence relation satisfying the equation $y_n = A(3)^n + B(-4)^n$	2	Und	2
14.	Write an explicit formula for a_n if $a_n = 3a_{n-1}$ and $a_1 = 2$.	2	Und	2
15.	Write the Principle of Inclusion and Exclusion.	2	Rem	2

PART-B

1.	(i) Using mathematical induction to show that $1^2 + 2^2 + 3^2 + \cdots \ldots + n^2 = \frac{n(n+1)(2n+1)}{6}$ whenever *n* is a positive integer.	2	App	8
	(ii) Using mathematical induction prove that $1^2 + 3^2 + 5^2 \ldots \ldots + (2n-1)^2 = \frac{n(2n-1)(2n+1)}{3}$ for all $n \geq 1$.	2	App	8
2.	(i) Use mathematical induction to show that $1+2+3+\ldots.+n = \frac{n(n+1)}{2}$.	2	App	8
	(ii) Solve the recurrence relation $a_n = 8a_{n-1} - 16a_{n-2}$ for $n \geq 2$, $a_0 = 16,\ a_1 = 80$.	2	App	8
3.	(i) Solve the recurrence relation $a_n = 6a_{n-1} - 9a_{n-2}, n \geq 2, a_0 = 2, \quad a_1 = 3.$	2	App	8
	(ii) Show that the sequence $\{a_n\}$ is a solution of the recurrence relation $a_n = a_{n-1} + 2\,a_{n-2} + 2n - 9$ if $a_n = 3(-1)^n + 2^n - n + 2$.	2	App	8
4	(i)Solve the recurrence relation $a_{n+2} = 4a_{n+1} - 4a_n \ , n \geq 0, a_{0=}1\ , a_1 = 3.$	2	App	8
	(ii) 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 principle of inclusion and exclusion, find the number of students who studied Chemistry only and the number who studied none of these subjects?	2	App	8
5.	(i) In how many arrangements of the letters of the word PHOTOGRAPH are there with exactly 5 letters between the two H^s?	2	Und	8
	(ii) A survey of 100 students with respect to their choice of the ice cream flavours Vanilla, Chocolate and Straberry shows that 50 students like Venilla, 43 like Chocolate, 28 like Strawberry, 13 like Venilla and Strawberry, 11 like Chocolate and Strawberry, 12 like Strawberry and Venilla, and 5 like all of them. Find the number of students who like (i) Venilla only (ii) Chocolate only (iii) Strawberry only (iv) number of students who do not like any of these.	2	App	8
6.	(i) Prove by mathematical induction that $6^{n+2} + 7^{2n+1}$ is divisible by 43 for each positive integer 'n'.	2	App	8
	(ii) Use mathematical induction to prove the inequality $n < 2^n$ for all positive integer n.	2	App	8

UNIT – 3

GRAPHS

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

Q. NO	QUESTION	CO	BTL	Marks
	PART–A			
1.	Define a complete graph with example.	3	Rem	2
2	What is meant by simple graph? Give an example.	3	Rem	2
3.	Define a regular graph.	3	Rem	2
4.	State the handshaking theorem.	3	Rem	2
5.	Define Pseudo graph.	3	Rem	2
6.	Draw the graph represented by the given adjacency matrix $\begin{bmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \end{bmatrix}$	3	Und	2
7.	Show that the simple graphs with the following adjacency matrices are isomorphic. $\begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$, $\begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix}$.	3	Und	2
8.	Define path.	3	Rem	2
9.	Define degree of a vertex in a graph.	3	Rem	2
10.	State the necessary and sufficient conditions for the existence of an Eulerian path in connected graph.	3	Rem	2
11.	Draw a complete bipartite graph of $K_{2,3}$ and $K_{3,3}$	3	Rem	2
12.	Give an example of an Euler graph.	3	Rem	2
13.	Give an example of a non-Eulerian graph which is Hamiltonian.	3	Rem	2
14.	Define isomorphism between graphs.	3	Rem	2

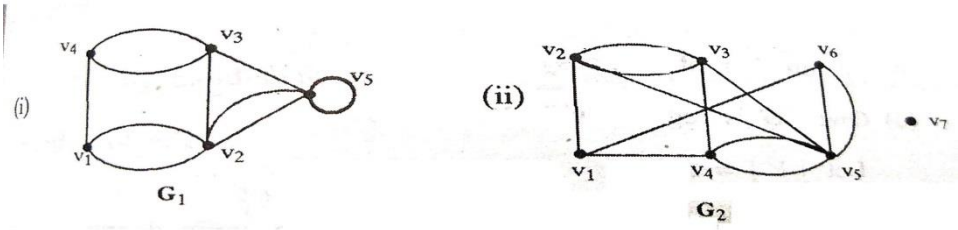
15. Give an example of a graph which is Eulerian but not Hamiltonian. 3 Rem 2

PART-B

1. (i) In any graph G, prove that the total number of odd-degree vertices is even. 3 App 8

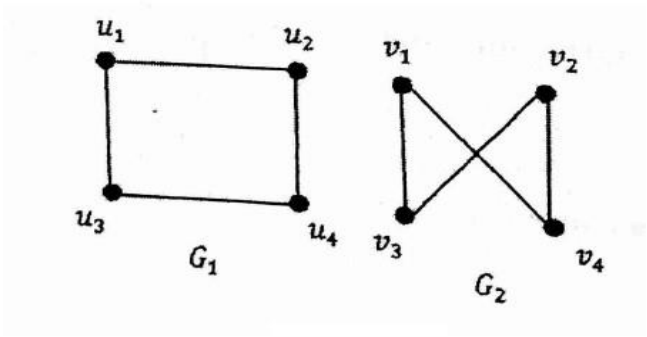
   (ii) Show that the maximum number of edges in a simple graph with *n* vertices is $\frac{n(n-1)}{2}$. 3 App 8

2. (i) Find the number of vertices, number of edges and the degree of each vertex. Verify the handshaking theorem.



   (ii) Prove that maximum number of edges in a simple disconnected graph G with 'n' vertices and 'k' Components is $\frac{(n-k)(n-k+1)}{2}$. 3 App 8

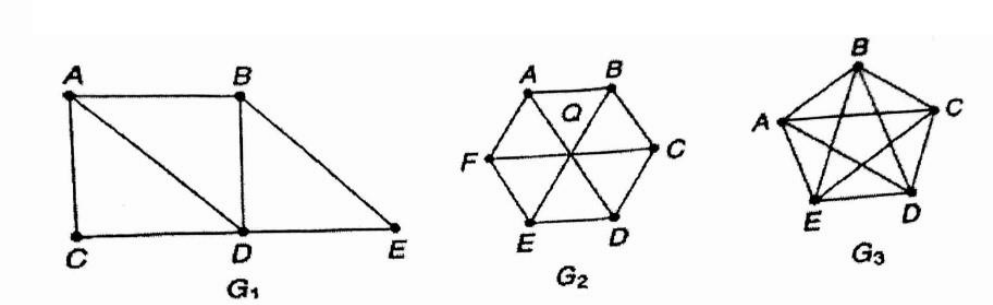
3. (i) Determine whether the following graphs G1 and G2 are isomorphic.



   3 App 8

   (ii) Find an Euler path or an Euler circuit, if it exists in each of the three graphs below. If it does not exist, explain why?

   3 App 8



4.	(i) Draw the graph with the adjacency matrix $\begin{bmatrix} 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 \end{bmatrix}$ with respect to the ordering of A, B, C,D.	3	Und	8
	(ii)Draw the directed graph corresponding to the adjacency matrix and also find the indegree and outdegree for each of the vertices. $\begin{bmatrix} 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$	3	Und	8
5.	(i) Prove that a connected graph 'G' is an Euler graph if only if all the vertices of ' G ' are of even Degree.	3	App	8
	((ii) Draw the graph with 5 vertices A,B,C,D,E such that deg(A) = 3 , B is an odd vertex , deg(C) = 2 and D and E are adjacent.	3	Und	8
6.	(i) State and prove Hand shaking theorem .	3	App	8
	(ii)If G is a simple graph with n vertices with minimum degree $(G) \geq \frac{n}{2}$, show that G is connected.	3	App	8

UNIT – 4

ALGEBRAIC STRUCTURES

Algebraic systems – Semi groups and monoids - Groups – Subgroups – Homomorphism's – Normal subgroup and cosets – Lagrange's theorem.

Q. NO	QUESTION	CO	BTL	Marks
	PART–A			
1.	State any two properties of a group.	4	Rem	2
2.	Define monoid.	4	Rem	2
3.	Define a semi-group.	4	Rem	2
4.	Prove that identity element is unique in a group.	4	Rem	2
5.	Find the idempotent elements of G={1, -1, i, -i}under the binary operation multiplication.	4	Und	2
6.	Show that if every element in a group is its own inverse, then the group must be abelian.	4	Und	2
7.	Prove that if G is abelian group then for all $a,b \in G$ $(a*b)^2 = a^2 * b^2$.	4	Und	2
8.	Show that every cyclic group is abelian.	4	Und	2
9.	When is a group (G,*) called abelian?	4	Rem	2
10.	Given $G = \{1, -1, i, -i\}$ is a group under usual multiplication and $H = \{1, -1\}$ is a subset of G. Find the index of H in G.	4	Und	2
11.	Find the left cosets of {[0], [3]} in the group $(Z_6, +_6)$	4	Und	2
12.	If 'a' is a generator of a cyclic group G then show that a^{-1} is also a generator of G.	4	Und	2

13.	Prove that every subgroup of an abelian group is a normal subgroup.	4	Und	2
14.	Show that $(Z_5, +_5)$ is a cyclic group.	4	Und	2
15.	Find all the cosets of the sub group $H = \{1, -1\}$ in $G = \{1, -1, i, -i\}$ with the operation multiplication.	4	Und	2

PART-B

1.	(i) If H_1 and H_2 are subgroups of a group (G,*) prove that $H_1 \cap H_2$ is a subgroup of (G,*).	4	App	8
	(ii) Let (G, *) be a group, then prove that (i) For each $a \in G, (a^{-1})^{-1} = a$ (ii) For all, $a, b \in G, (a * b)^{-1} = b^{-1} * a^{-1}$ for all $a, b \in G$	4	App	8
2.	(i) Let $Z_5^* = \{[1], [2], [3], [4]\}$ be the non-zero elements of Z_5. Prove that $(Z_5^*, \cdot_5)$ is an abelian group.	4	App	8
	(ii) Show that the set of all non-zero real numbers is an abelian group under the operation * defined by $a * b = \frac{ab}{2}$.	4	App	8
3.	(i) Show that $(Z_m, +_m)$ is an abelian group.	4	App	8
	(ii) Show that the intersection of two normal subgroup of a group (G,*) is a normal subgroup of (G,*).	4	App	8
4.	(i) State and prove Lagrange's theorem.	4	App	8
	(ii) Show that Kernal of a group homomorphism is a normal subgroup of the group.	4	App	8
5.	(i) If * is a binary operation on the set R of real numbers defined by a*b = a+b+2ab , a) Find (R, *) is a semigroup b) Find the identity element if it exist . c) Which element has inverse and what are they?	4	App	8
	(ii) Prove that the necessary and sufficient condition for non-empty subset H of a group {G , *} to be subgroup is $a, b \in H \Rightarrow a * b^{-1} \in H$.	4	App	8
6.	(i)Show that every subgroup of a cyclic group is cyclic.	4	App	8

	(ii)If H and K are subgroup of G, prove that $H \cup K$ is a subgroup of G if and only if either $H \subseteq K$ or $K \subseteq H$	4	App	8
7.	(i) If $(G,*)$ *and* (H,Δ) are two groups and $g:(G,*)\to(H,\Delta)$ is a group homomorphism then prove that kernel of g is normal subgroup of (G,*).	4	App	8
	(ii) If <H,* > is a subgroup of <G,* > then show that <H,* > is a normal subgroup iff $a * h * a^{-1} = H, \forall a \in G$.	4	App	8
8.	State and prove the fundamental theorem on homomorphism of groups.	4	App	16

UNIT – 5

LATTICES AND BOOLEAN ALGEBRA

Partial ordering – Posets – Lattices as posets – Properties of lattices - Lattices as algebraic systems– Sub lattices – Some special lattices – Boolean algebra – SubBoolean Algebra – Boolean Homomorphism.

Q. NO	QUESTION	CO	BTL	Marks
	PART–A			
1.	Define a partially ordered set.	5	Rem	2
2	Draw a Hasse diagram of $D_{20} = \{1,2,4,5,10,20\}$.	5	Und	2
3.	Draw a Hasse diagram of $D_{12} = \{1,2,3,4,6,12\}$.	5	Und	2
4.	Define Lattice.	5	Rem	2
5.	State the distributive inequalities in Lattice.	5	Rem	2
6.	In a distributive lattice prove that complement of an element, if it exists, is unique.	5	Rem	2
7.	Define Boolean algebra.	5	Rem	2
8.	Prove that $(a')' = a$ for all $a \in B$ where B is a Boolean Algebra.	5	Und	2
9.	If B is a Boolean algebra then prove that for $a \in B$, $a + 1 = 1$and $a.0 = 0$.	5	Und	2
10.	State De Morgan's law in Boolean Algebra.	5	Rem	2
11.	Draw the Hasse – diagram of the set of partitions of 5.	5	Und	2

12.	Give an example of a lattice which is a modular but not a distributive.	5	Rem	2
13.	If A = {2,3} $\subseteq$ X = {2,3,6,12,24,36} and the relation $\leq$ is such that x $\leq$ y is x divides y, find the least element and greatest element for A.	5	Und	2
14.	Define Sub lattices.	5	Und	2
15.	In any Boolean algebra, show that a = b if and only if $a\bar{b} + \bar{a}b = 0$.	5	Und	2

PART-B

1.	(i) Let D_{24} be the set of divisors of 24 and the relation $\leq$ is $a \leq b$ if $a \mid b$. Draw the Hasse diagram for the poset $(D_{24}, \mid)$.	5	App	8
	(ii) Let $(L, \leq)$ be a lattice. For any $a, b, c \in L$ the following properties called isotonicity hold. If $b \leq c$ then (i) $a * b \leq a * c$ (ii) $a \oplus b \leq a \oplus c$.	5	App	8
2.	(i) Let $(L, \leq)$ be a lattice. For any $a, b, c \in L$ the following inequalities hold. (i) $a \oplus (b * c) \leq (a \oplus b) * (a \oplus c)$ (ii) $a * (b \oplus c) \geq (a * b) \oplus (a * c)$.	5	App	8
	(ii) State and Prove De Morgan's law in Lattice.	5	App	8
3.	(i) Prove that every chain is a distributive lattice.	5	App	8
	(ii) In a distributive lattice (L, *, $\oplus$) if for any $a, b, c \in L$, $a * b = a * c$ and $a \oplus b = a \oplus c$ then $b = c$.	5	App	8
4.	(i) In a Boolean Algebra show that $ab' + a'b = 0$ if and only if $a = b$.	5	App	8
	(ii) In a Boolean Algebra, prove that the following statements are equivalent (i) $a + b = b$ (ii) $a.b = a$ (iii) $a' + b = 1$ (iv) $a.b' = 0$.	5	App	8
5.	(i) State and Prove De Morgan's law in Boolean Algebra.	5	App	8
	(ii)Prove that every distributive lattice is modular. Is the converse true? Justify your claim.	5	Ana	8

6.	(i) In a distributive lattice prove that $a*b=a*c$ and $a\oplus b=a\oplus c$ imply $b=c$.	5	App	8
	(ii)In Boolean algebra, prove that $(a\wedge b)'=a'\vee b'$ for all a,b∈L.	5	App	8
7.	(i)In a lattice show that $a\le b\Rightarrow a*b=a$.	5	App	8
	(ii) Draw the Hasse – diagram of the Lattice L of all subsets of {a, b, c} under intersection and union.	5	App	8
8.	(i)Show that if L is a distributive lattice then for all $a,b,c\in L,\ (a*b)\oplus(b*c)\oplus(c*a)=(a\oplus b)*(b\oplus c)*(c\oplus a)$	5	App	8
	(ii) Show that in a distributive and complemented lattice $a\le b\Leftrightarrow a*b'=0\Leftrightarrow a'\oplus b=1\Leftrightarrow b'\le a'$	5	App	8

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24ECPC306

DIGITAL PRINCIPLES AND COMPUTER ORGANIZATION

UNIT I

COMBINATIONAL LOGIC

Combinational Circuits – Karnaugh map -5 variable Karnaugh map, don't care conditions - Analysis and Design Procedures – Binary Adder-Subtractor – Decimal Adder - Magnitude Comparator – Decoder – Encoder – Multiplexers - De-multiplexers.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	List the four possible elementary operations simple binary addition consists of.	1	REM	2
2.	Which combinational circuit is otherwise known as data selector? why?	1	REM	2
3.	Outline a full adder by using two half adders and OR gate.	1	UND	2
4.	Compare the function of decoder and encoder .	1	UND	2
5.	Give disadvantage of half adder and full adder.	1	REM	2
6.	Draw the logic diagram of a 2 to 4 line decoder circuit?	1	REM	2
7.	The output Y of a 2-bit comparator is logic1whenever the 2-bit input A is greater than the 2-bit input B. What is the number of combinations for which the output is logic 1?	1	REM	2
8.	Draw the logic circuit of a 2-bitcomparator.	1	REM	2
9.	List out the applications of multiplexer.	1	REM	2
10.	In what way encoder differs from decoder?	1	REM	2
11.	Write down the Borrow and Subtractor equation of full subtractor.	1	REM	2
12.	Compare Sequential circuit and Combinational circuit	1	UND	2
13.	Outline the truth table with three inputs and one output. The output is 1 when the binary value of the inputs is less than three. The output is zero otherwise.	1	UND	2

14.	Recall how many selection inputs, data inputs and outputs for 1*32 Demultiplexer?	1	REM	2
15.	Give the function of Priority encoder with example.	1	REM	2

PART B

1.	Simplify below boolean function expression considering don't care conditions using 4 variable K map $F(A,B,C,D) = \sum(1,2,4,5,8,9,10,12)+d(3,6,7,13,14)$.	1	ANA	16
2.	Develop a combinational circuit with three inputs, x, y and z and three outputs, A, B and C. When the binary input is 0, 1, 2 or 3 the binary output is one greater than the input. When the binary input is 4,5,6 or 7, The binary output is one less than the input.	1	APP	16
3.	Develop a 4 bit adder and subtractor circuit and explain.	1	APP	16
4.	Construct 2-bit magnitude comparator with three outputs: A>B, A<B and A=B.	1	APP	16
5.	Build BCD adder and explain how it differ from 4 bit binary adder.	1	APP	16
6.	Build three to eight line decoder circuit using inverters and AND gates. Also, present the truth table for the same.	1	APP	16
7.	a)Develop the Boolean expression F (A, B, C) = Σm (0, 2, 5, 6) using 4:1 multiplexer. b)Develop the Boolean expression F(A,B,C,D) = $\sum$m(0,1,3,4,8,9,15) using suitable multiplexer.	1 1	APP APP	8 8
8.	What is a K-Map? Simplify the Boolean function F (A,B,C,D,E) = $\sum_m$(1, 2, 4, 5, 6, 8, 9, 12, 13, 14,16,17,20,23,28,30,32) using K-Map.	1	ANA	16

UNIT II

SYNCHRONOUS SEQUENTIAL LOGIC

Introduction to Sequential Circuits – Flip-Flops – operation and excitation tables, Triggering of FF,Analysis and design of clocked sequential circuits – Design – Moore/Mealy models, state minimization, state assignment, circuit implementation - Registers – Counters.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Outline the difference between asynchronous sequential circuit and synchronous sequential circuit.	2	UND	2
2.	How does ripple counter differ from synchronous counter?	2	REM	2
3.	How do you eliminate the race around condition in a JK flip-flop?	2	REM	2
4.	Compare latches and flip-flops.	2	UND	2
5.	Explain about D-Latch with truth table.	2	UND	2
6.	List the different types of shift registers.	2	REM	2
7.	Define the terms :state table and state assignment.	2	REM	2
8.	Compare Mealy and Moore state machines.	2	UND	2
9.	Compare edge triggering and level triggering in sequential circuits.	2	UND	2
10.	Find minimum number of flip-flops needed to design a counter of Modulus 60.	2	REM	2
11.	Construct a NAND based logic diagram of Master Slave JK FF.	2	APP	2
12.	Illustrate the logic diagram of a clocked SR Flipflop.	2	UND	2

13.	Show the operation of T FF.	2	REM	2
14.	Define Counters and its types.	2	REM	2
15.	Develop a Mealy machine to detect the sequence **"10"** and output **1** when detected. Otherwise, output **0**.	2	APP	2

PART B

1.	Explain SR FF using NAND gate and derive its characteristic table, characteristic equation and Excitation table.	2	UND	16
2.	Explain in detail about 4 bit Johnson counter.	2	UND	16
3.	Which flip flop is called as data flip flop? explain the operation of same with its circuit diagram, characteristic table and excitation table.	2	UND	16
4.	Outline the design of a BCD Ripple counter using JK Flip flops with state diagram and logic diagram	2	UND	16
5.	Develop a Mod-5 synchronous counter using JK flip flop.	2	APP	16
6.	Summarize the design procedure for asynchronous sequential circuit.	2	UND	16
7.	What are registers? Construct a 4 bit universal shift register using D FF and explain the operation of register.	2	UND	16
8.	Explain Mealy and Moore Models with the help of block diagram.	2	UND	16

UNIT III

COMPUTER FUNDAMENTALS

Functional Units of a Digital Computer: Von Neumann Architecture – Operation and Operands of Computer Hardware Instruction – Instruction Set Architecture(ISA):Memory Location, Address and Operation – Instruction and Instruction Sequencing – Addressing Modes, Encoding of Machine Instruction – Interaction between Assembly and High Level Language.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is the role of control unit in the operation of digital computer.	3	REM	2
2.	Define computer architecture.	3	REM	2
3.	Name the functional units of computer.	3	REM	2
4.	What is Von Neumann bottleneck?	3	REM	2
5.	Outline instruction cycle with diagram.	3	UND	2
6.	What is the role of PC?	3	REM	2
7.	What is operation code?	3	UND	2
8.	Interpret instruction set architecture (ISA)	3	UND	2
9.	What are the data transfer instructions?	3	REM	2
10.	Compare direct and indirect addressing modes.	3	UND	2
11.	List the types of addressing modes.	3	REM	2
12.	What is meant by an addressing mode? Mention most important of them.	3	REM	2
13.	Compare auto increment and auto decrement addressing mode.	3	UND	2
14.	Define compiler.	3	REM	2
15.	Compare machine level, assembly level and high level languages.	3	UND	2

PART B

1.	A) Explain the fundamental units of digital computer. B) Explain instruction cycle.	3	UND UND	8 8
2.	Explain Von Neumann architecture with neat sketch and features.	3	UND	16
3.	Explain in detail about the various operands of the computer hardware.	3	UND	16
4.	Illustrate Byte addressability (4) Big endian assignment (6) Little endian assignment (6)	3	UND	16
5.	Mention four types of operations required to be performed by instruction in a computer. classify types of instruction formats? Give an example for each.	3	UND	16
6.	Define addressing mode. Explain the basic addressing mode with an example for each.	3	UND	16
7.	A) Explain about encoding in assembly language and types of instructions.(8) B) Discuss the interconnection between assembly language and high level language.(8)	3	UND	16
8.	Explain the data transfer operations between memory and the processor.	3	UND	16

UNIT IV

PROCESSOR

Instruction Execution–Building a Data Path–Designing a Control Unit–Hard wired control Microprogrammed Control – Pipelining – Data Hazard – Control Hazards.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	List the operations involved in instruction cycle.	4	REM	2
2.	Outline the data path segment for arithmetic-logic instructions.	4	UND	2
3.	What is the ideal speed-up expected in a pipelined Architecture with ‘n’ stages? Justify your answer.	4	REM	2
4.	What do you mean by pipelining? List its types.	4	REM	2
5.	Compare static and dynamic techniques.	4	UND	2
6.	What is branch hazard?	4	REM	2
7.	What is meant by speculative execution?	4	REM	2
8.	Compare data hazards and control hazards.	4	UND	2
9.	Differentiate: Hardwired control and micro programmed control	4	UND	2
10.	What is program counter?	4	REM	2
11.	When do data hazard occur in pipelining?	4	REM	2
12.	What is a data path?	4	REM	2
13.	What is exception?	4	REM	2
14.	What is a branch prediction buffer?	4	REM	2

15.	What is the need for speculation?	4	REM	2

PART B

1.	Outline the difference between hardwired control and micro programmed control.	4	UND	16
2.	What is hazard? Analyze hazard free realization for the following Boolean functions F(A, B, C, D) = ∑m (1, 5, 6, 7) using AND-OR gate network.	4	ANA	16
3.	Explain why branch prediction algorithm needed? Differentiate between the static and dynamic techniques.	4	UND	16
4.	Illustrate pipeline hazards. Outline the types of pipeline hazards.	4	UND	16
5.	Construct a simple MIPS data path with control unit and explain the execution of ALU instruction.	4	APP	16
6.	Outline the methods for avoiding the control hazards.	4	UND	16
7.	Illustrate about data hazards. Explain with suitable techniques, how these hazards can be mitigated?	4	UND	16
8.	Explain how instruction is being fetched and executed through the data path in the processor?	4	UND	16

UNIT V

MEMORY AND I/O

Memory Concepts and Hierarchy – Memory Management – Cache Memories: Mapping and Replacement Techniques – Virtual Memory – DMA – I/O – Accessing I/O: Parallel and Serial Interface – Interrupt I/O – Interconnection Standards: USB, SATA.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is a direct-mapped cache?	5	REM	2
2.	What is hit time?	5	REM	2
3.	Which signal is used to notify the processor that the transfer is completed? Define.	5	REM	2
4.	Mention the modes of DMA transfer.	5	REM	2
5.	Outline of interrupt driven I/O.	5	UND	2
6.	What is memory mapped I/O?	5	REM	2
7.	Define supervisor / kernel / executive state.	5	REM	2
8.	List the advantages of virtual memory?	5	REM	2
9.	Explain the concept of memory hierarchy in a computer system.	4	UND	2
10.	Compare main memory and cache memory based on access time and cost.	4	UND	2
11.	Illustrate the role of virtual memory with the help of a block diagram.	4	UND	2
12.	Summarize the need for Direct Memory Access (DMA) in data transfer.	4	UND	2
13.	Outline the differences between parallel and serial I/O interfaces.	4	UND	2
14.	Classify different cache mapping techniques.	4	UND	2
15.	Infer the importance of interconnection standards like USB and SATA.	4	UND	2

PART B

1.	Present an outline of virtual address, physical address, address translation, segmentation, page table, swap space and page fault.	5	UND	16
2.	Explain interconnection standards.	5	UND	16
3.	Construct a direct memory access with a diagram and mention its advantage.	5	APP	16
4.	Describe the various mechanisms for accessing I/O devices.	5	ANA	16
5.	Explain how memory mapping techniques are useful for finding the memory blocks in cache?	5	UND	16
6.	How virtual addresses are translated into physical addresses? Explain it with the help of virtual memory organization and page translation.	5	UND	16
7.	Examine the role of I/O interfaces in system bottlenecks.	5	ANA	16
8.	Analyze how cache memory improves performance with respect to memory hierarchy.	5	ANA	16

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DATABASE DESIGN AND MANAGEMENT

UNIT I

DATABASE SYSTEM CONCEPTS AND ARCHITECTURE

Understanding Data and Information - Database vs DBMS-characteristics of database - Advantages of using DBMS – Data Models, Schemas, and Instances– Three-Schema Architecture and Data Independence– The Database System Environment– Centralized and Client/Server Architectures for DBMSs – Classification of database management systems – Database system development lifecycle – Database design - Entity-Relationship model – Enhanced-ER model – UML class diagrams

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define data and information.	1	Rem	2
2.	Compare database and DBMS.	1	Und	2
3.	Define database environment.	1	Rem	2
4.	State metadata with example.	1	Rem	2
5.	Define schema and instance.	1	Rem	2
6.	Define data model. List various data model.	1	Rem	2
7.	State the purpose of the three-schema architecture.	1	Und	2
8.	Outline the role of data dictionary in DBMS	1	Und	2
9.	List characteristics of a database.	1	Rem	2
10.	List advantages of using DBMS	1	Rem	2
11.	Define entity and attribute with example.	1	Rem	2
12.	Compare generalization and specialization.	1	Und	2
13.	State aggregation in EER model	1	Rem	2
14.	Outline the purpose of UML class diagrams in database design	1	Und	2
15.	List limitation of ER model and how do you overcome this.	1	Rem	2
	PART B			
1.	Compare database Vs file processing system.	1	Und	16
2.	(i) Explain the three-schema architecture. (ii) Highlight the importance of data independence.	1	Und	10 6
3.	(i) Explain centralized and client/server architectures. (ii) Compare their features.	1	Und	10 6

4.	Explain various data models in DBMS with example	1	Und	16
5.	Construct ER diagram for hospital management system	1	App	16
6.	Apply the concept of the Database System Development Lifecycle (DSDLC) to a real-time application and illustrate its phases with a neat diagram	1	App	16
7.	Apply the concepts of data modeling to compare ER and EER diagrams with suitable examples	1	App	16
8.	Construct ER diagram for a university database that stores information about departments, professors, courses, and student	1	App	16

UNIT II

RELATIONAL MODEL AND SQL

SQL Query Language - Data types and Schema - SQL Data Definition - SQL Data manipulation - Basic Structure of SQL Queries - Additional Basic Operations - Set Operations - Null Values - Aggregate Functions - Nested Sub queries - Join Expressions - Views - Integrity Constraints - Index Definition in SQL - Accessing SQL from a Programming Language - Functions and Procedures – Triggers

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define schema in SQL.	2	Rem	2
2.	Compare CHAR and VARCHAR data types.	2	Und	2
3.	Define the SELECT statement with a WHERE clause.	2	Rem	2
4.	State what does the DISTINCT keyword do in SQL	2	Rem	2
5.	Write a simple SQL query to display all records from a table named STUDENTS.	2	Und	2
6.	State nested subquery	2	Rem	2
7.	Outline the purpose of aggregate functions	2	Und	2
8.	Write the syntax for creating a view.	2	Und	2
9.	Compare INNER JOIN and OUTER JOIN	2	Und	2
10.	Write SQL syntax to create an index on a column.	2	Und	2
11.	Compare function and a procedure	2	Und	2
12.	Define a function in SQL.	2	Rem	2
13.	Compare COUNT(*) and COUNT (column_name)	2	Und	2
14.	Outline the purpose of BEFORE and AFTER triggers.	2	Und	2
15.	Write the SQL command to add a primary key to an existing table.	2	Und	2
	PART B			
1.	Explain various SQL data types with examples	2	Und	16
2.	Describe Data Definition Commands with example	2	Und	16
3.	Explain Data Manipulation Commands with example	2	Und	16

4.	Summarize basic SQL operations with suitable examples (SELECT, WHERE, ORDER BY, GROUP BY).	2	Und	16
5.	Explain nested subqueries in SQL with examples of IN, ANY, ALL, and EXISTS.	2	Und	16
6.	Apply the SQL operators AND, OR, and NOT in query construction and identify their effect on retrieved data with suitable examples	2	App	16
7.	Define and construct a stored procedure in SQL; build a procedure to insert student data into a table and identify its advantages	2	App	16
8.	Interpret different types of joins with example	2	Und	16

UNIT III

RELATIONAL DATABASE DESIGN AND NORMALIZATION

ER and EER-to-Relational mapping – Update anomalies – Functional dependencies – Non-Loss Decomposition Functional Dependencies- Inference rules – Minimal cover – Properties of relational decomposition – Normalization (upto BCNF).

Q.No	Question	CO	BTL	Marks

PART A

1.	Define ER-to-Relational mapping.	3	Rem	2
2.	Outline insertion anomaly with example.	3	Und	2
3.	Define minimal cover.	3	Rem	2
4.	Define functional dependency	3	Rem	2
5.	Define BCNF.	3	Rem	2
6.	Outline lossless decomposition	3	Und	2
7.	State inference rules in functional dependencies	3	Rem	2
8.	List Armstrong's axioms	3	Rem	2
9.	Define transitive dependency.	3	Rem	2
10.	Define normalization	3	Rem	2
11.	State the role of normalization in database design	3	Und	2
12.	Outline the significance of minimal cover	3	Und	2
13.	Compare 3NF and BCNF	3	Und	2
14.	State multivalued dependency	3	Rem	2
15.	Define trivial dependency	3	Rem	2

PART B

1.	Explain the steps involved in mapping an ER diagram to a relational schema with an example.	3	Und	16
2.	Analyze the concept of Functional Dependencies in relational databases with suitable examples	3	Ana	16
3.	Examine the process of Normalization and explain the different Normal Forms with examples	3	Ana	16

4.	Interpret the properties of relational decomposition.	3	Und	16
5.	What is minimal cover? Describe the steps to compute it with example.	3	Und	16
6.	Discuss the differences between lossy and lossless decomposition with examples.	3	Und	16
7.	Apply normalization concepts to construct a schema for a medical clinic system (patients, doctors, appointments, billing).	3	App	16
8.	For relation R(A, B, C) with F = {A → B, B → C, C → A}, identify the minimal cover, develop the candidate keys, and construct the BCNF decomposition if required.	3	App	16

UNIT IV

TRANSACTION MANAGEMENT AND OBJECT DATABASE SYSTEMS

Transaction concepts – properties – Schedules – Serializability – Concurrency Control: Lock-based protocols – Locks, granting of locks, the two-phase locking protocol, implementation of locking, Graph-based protocols – Object Database: User Defined Abstract Data Types –Structured Types – Object - Object identity– reference types - Inheritance – Database Design for an ORDBMS

Q.No	Question	CO	BTL	Marks

PART A

1.	Define transaction in DBMS.	4	Rem	2
2.	List the ACID properties.	4	Rem	2
3.	Outline the schedule in DBMS.	4	Und	2
4.	Define serializability.	4	Rem	2
5.	Define precedence graph.	4	Rem	2
6.	State the need for concurrency control.	4	Rem	2
7.	Compare shared lock and exclusive lock.	4	Und	2
8.	Outline how is deadlock detected in DBMS.	4	Und	2
9.	State timestamp ordering protocol.	4	Rem	2
10.	List two features of ORDBMS.	4	Rem	2
11.	State one advantage of ORDBMS over RDBMS.	4	Rem	2
12.	Define inheritance in the context of OODBMS.	4	Rem	2
13.	Outline reference types in object databases.	4	Und	2
14.	State the purpose of object identifiers (OIDs).	4	Rem	2
15.	State structured type in ORDBMS.	4	Rem	2

PART B

1.	Explain the ACID properties of transactions with examples.	4	Und	16
2.	Describe the life cycle of a transaction.	4	Und	16
3.	Discuss lock-based protocol with example	4	Und	16
4.	Explain the working of the two-phase locking protocol with a schedule.	4	Und	16

5.	Differentiate OODBMS and RDBMS	4	Ana	16
6.	Apply the concept of inheritance in Object-Oriented Databases (OODB) and illustrate it with suitable examples from real-world entities	4	App	16
7.	Deduce structured types in ORDBMS with suitable SQL syntax and example	4	Ana	16
8.	Design and develop an object-relational schema for a Hospital Management System. Explain each component of your design by. showing how it supports data consistency and reduces redundancy	4	App	16

UNIT V

NO-SQL DATABASES

No-SQL: Introduction to NoSQL- Features – Types - CAP theorem – Document-Oriented Databases: MongoDB – Architecture – Data Modeling in MongoDB – Advantages over RDBMS – Mongo Shell and Configuration- JSON File Format - CRUD operations; Column-based: HBase data model and CRUD operations

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define NoSQL.	5	Rem	2
2.	Outline the need for NoSQL databases.	5	Und	2
3.	State CAP theorem in NoSQL.	5	Rem	2
4.	Define document-oriented database.	5	Rem	2
5.	Outline the role of _id in MongoDB documents.	5	Und	2
6.	State collection in MongoDB.	5	Rem	2
7.	List the basic CRUD operations in MongoDB.	5	Rem	2
8.	Define HBase.	5	Rem	2
9.	List any two advantages of NoSQL over traditional databases.	5	Rem	2
10.	Outline what command is used to insert a document in MongoDB.	5	Und	2
11.	Define JSON.	5	Rem	2
12.	List two examples of document-oriented databases.	5	Rem	2
13.	Define availability in the CAP theorem context.	5	Rem	2
14.	Compare MongoDB and HBase	5	Und	2
15.	Define the term "collection" in the context of MongoDB.	5	Rem	2
	PART B			
1.	Simplify the CAP theorem in detail with real-time examples.	5	Ana	16
2.	Discuss the architecture of MongoDB with a neat diagram.	5	Und	16

3.	Apply MongoDB concepts to construct a JSON document for storing patient details in a hospital system. Identify and explain the purpose of each field used	5	App	16
4.	Illustrate the steps for MongoDB installation and configuration.	5	Und	16
5.	Analyze the role of JSON and BSON in MongoDB data exchange.	5	Ana	16
6.	Explain the syntax for inserting, updating, deleting, and retrieving data from MongoDB	5	Und	16
7.	Demonstrate basic CRUD operations in MongoDB using Mongo Shell commands	5	Und	16
8.	Develop a MongoDB database for a hospital by creating collections for doctors, patients, and appointments. Apply your design to construct relationships between these collections and identify how the structure supports efficient data management.	5	App	16

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DATA STRUCTURES

UNIT I

ABSTRACT DATA TYPES AND INTRODUCTION TO ANALYSIS OF ALGORITHMS

Abstract Data Types (ADTs) – ADTs and classes – introduction to OOP – classes in Python – inheritance – namespaces – Overview and importance of algorithms and data structures. Fundamentals of algorithm analysis, Space and time complexity of an algorithm, Types of asymptotic notations and orders of growth, Algorithm efficiency – best case, worst case, average case, Analysis of non-recursive and recursive algorithms, Asymptotic analysis for recurrence relation – Recursive Tree Method..

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define Abstract Data Type (ADT).	1	Rem	2
2.	Mention the features of ADT.	1	Rem	2
3.	List the use of inheritance in object-oriented programming.	1	Rem	2
4.	Mention any two features of Object-Oriented Programming.	1	Und	2
5.	Differentiate between class and object in Python.	1	Und	2
6.	Define time complexity of an algorithm.	1	Und	2
7.	Define space complexity with an example.	1	Rem	2
8.	Write the syntax for defining a class in Python.	1	Und	2
9.	State the importance of analyzing algorithms.	1	Und	2
10.	Define worst-case time complexity. Give an example.	1	Und	2
11.	Outline the significance of the recursive tree method.	1	Und	2
12.	Distinguish between recursive and non-recursive algorithms.	1	Und	2
13.	Give the order of growth for the following: O(1), O(n^2), O(log n).	1	Und	2

14.	Outline the purpose of the __init__ method in Python classes?	1	Und	2
15.	Define recursion in data structures.	1	Und	2

PART B

1.	i) Define Abstract Data Types (ADTs) with examples. ii) Differentiate between ADTs and classes. iii) Explain how Python supports ADTs through classes with real-time examples.	1	Und	6 4 6
2.	a) Explain the major principles of Object- Oriented Programming (OOP): Encapsulation Inheritance Polymorphism Abstraction b) Illustrate each concept with suitable Python-based examples.	1	Und	6 10
3.	a) Define space and time complexity. b) Explain how to calculate time complexity with step-by-step analysis. c) Analyze the time and space complexity of a simple linear search algorithm.	1	App	4 6 6
4.	Write a Python program that implements an ADT for a simple Stack using classes. Include methods for push(), pop(), peek(), andisEmpty().Also analyze its time complexity.	1	App	16
5.	a) Define and compare Big-O, Omega (Ω), and Theta (Θ) notations. b) Explain different orders of growth with examples and graph. c) Justify why asymptotic notations are important in algorithm analysis.	1	Ana	4 8 4
6.	Design a Python class Person with attributes name and age. Create a subclass Student that inherits Person and adds roll_no. Demonstrate local and global namespace handling with print() statements.	1	App	16
7.	a) Write Python programs for generating Fibonacci numbers: Using recursion b) Compare the time complexities of both. c) Explain when recursion is less efficient than iteration.	1	Ana	4 6 6

8.	a) Implement a recursive function for MergeSort. b) Analyze and derive its recurrence relation. c) Use recursive tree method to explain the complexity T(n)=2T(n/2)+n	1	Eva	6 4 6

UNIT II

LINEAR STRUCTURES

Array- 1D and 2D array , Stack - Applications of stack: Expression Evaluation - Conversion of Infix to postfix and prefix expression, Tower of Hanoi. Queue - Types of Queue: Circular Queue, Double Ended Queue (deQueue), Applications – Priority Queue using Arrays – List - Singly linked lists – Doubly linked lists - Circular linked lists, Applications -Polynomial Manipulation - Josephus problem(permutation)

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define a one-dimensional array with an example.	2	Rem	2
2.	Mention any two applications of a stack.	2	Und	2
3.	State the purpose of infix to postfix conversion.	2	Und	2
4.	Convert the infix expression A + B * C to postfix.	2	Und	2
5.	Write the recursive relation for solving Tower of Hanoi.	2	Rem	2
6.	Differentiate between circular queue and deque.	2	Und	2
7.	Define priority queue? Give one application.	2	Rem	2
8.	Define singly linked list with a diagram.	2	Rem	2
9.	Differentiate between singly and doubly linked lists.	2	Und	2
10.	List the use of deQueue in real-world applications.	2	Und	2
11.	State any two real-time applications of linked lists.	2	Und	2

12.	Define polynomial manipulation in linked lists.	2	Und	2
13.	Write the algorithm to insert an element in a circular queue.	2	Und	2
14.	List the use of polynomial manipulation in linked lists.	2	Und	2
15.	Define Josephus problem and where is it applied.	2	Und	2

PART B

1.	Explain the structure and memory representation of 1D and 2D arrays. Compare them in terms of storage and access.	2	Und	16
2.	Write a Python program to implement a 1D array with operations: insert, delete, and search.	2	App	16
3.	What are the different types of queues? Explain circular queue and double-ended queue with advantages and disadvantages.	2	Rem	16
4.	Describe the applications of stacks in detail. How are stacks used in expression evaluation and recursion?	2	Und	16
5.	Explain the types of linked lists with diagrams. Differentiate between singly, doubly, and circular linked lists.	2	App	16
6.	Implement a circular queue using an array in Python with insert and delete operations.	2	App	16
7.	Write a Python program to convert an infix expression to postfix and prefix notation using a stack.	2	Ana	16
8.	What is a priority queue? How can it be implemented using arrays? Discuss its real-world applications.	2	Und	16

UNIT III

SORTING AND SEARCHING

Sorting: Bubble sort – selection sort – insertion sort – merge sort – quick sort , Analysis, Applications- Finding the ‘n’ closest pair’s – Search: linear search – binary search, Applications – Finding square root of ‘n’ longest common prefix.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define bubble sort.	3	Rem	2
2.	Write one advantage of insertion sort over bubble sort.	3	Und	2
3.	State the time complexity of selection sort in best and worst cases.	3	Und	2
4.	Compare merge sort and quick sort in terms of time complexity.	3	Und	2
5.	Mention two real-time applications of sorting algorithms.	3	Und	2
6.	Define the term "pivot" in quick sort.	3	Und	2
7.	State recurrence relation for merge sort.	3	Rem	2
8.	List two disadvantage of bubble sort.	3	Und	2
9.	Define linear search and write its worst-case time complexity.	3	Rem	2

10.	Differentiate between linear search and binary search.	3	Und	2
11.	State two limitations of binary search.	3	Und	2
12.	Write any two applications of searching in computer science.	3	Und	2
13.	Given the list [12, 7, 5, 3], show one pass of bubble sort.	3	Und	2
14.	Use binary search to find if 25 exists in the sorted list [10, 15, 20, 25, 30, 35].	3	Und	2
15.	Why is insertion sort preferred for small or nearly sorted datasets?	3	Und	2

PART B

1.	Compare and contrast Bubble Sort, Selection Sort, and Insertion Sort in terms of time complexity, algorithm steps, and use cases.	3	Und	16
2.	Write Python programs for Merge Sort and Quick Sort. Explain the working with a sample list.	3	App	16
3.	Explain how divide-and-conquer is used in Merge Sort and Quick Sort. Compare their best, average, and worst-case time complexities.	3	Ana	16
4.	Write Python programs for Linear Search and Binary Search. Compare their performance for sorted and unsorted arrays.	3	App	16
5.	Explain the method of finding the square root of a number using binary search. Write a Python program to demonstrate it.	3	Ana	16
6.	Explain with example how the partition step works in Quick Sort. Illustrate how it affects performance.	3	App	16

7.	Explain the applications of searching and sorting algorithms in real-life scenarios such as data retrieval, ranking, and recommendations.	3	Und	16
8.	Write a Python program to implement insertion sort and demonstrate how it sorts a list of integers step-by-step.	3	App	16

UNIT IV

NON-LINEAR DATA STRUCTURE

Tree ADT: Binary Tree ADT – tree traversals – binary search trees – AVL trees – heaps – multiway search trees - Graph ADT: Representations of graph – graph traversals – DAG – topological ordering – shortest paths – minimum spanning trees

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define a binary tree.	4	Rem	2
2.	List any two tree traversal methods.	4	Rem	2
3.	Difference between BST and AVL tree.	4	Und	2
4.	Define heap and mention its types.	4	Und	2
5.	Define multi-way search tree.	4	Rem	2
6.	Define graph.	4	Rem	2
7.	List the difference between DFS and BFS.	4	Rem	2

8.	Define DAG.	4	Und	2
9.	Define minimum spanning tree.	4	Rem	2
10.	Outline the balance factor in an AVL tree.	4	Und	2
11.	Define post-order traversal.	4	Rem	2
12.	Define adjacency list with an example.	4	Und	2
13.	List two applications of graph data structures.	4	Rem	2
14.	Outline the key idea behind Prim's algorithm.	4	Und	2
15.	Define topological ordering in DAGs.	4	Und	2

PART B

1.	Explain the structure of binary trees. Describe in-order, pre-order, and post-order traversal with an example.	4	Und	16
2.	Write a Python program to implement a Binary Search Tree (BST) with insert and search operations.	4	App	16
3.	Explain AVL trees. How do rotations maintain balance? Illustrate with suitable examples.	4	Ana	16
4.	Explain graph representations: adjacency matrix and adjacency list. Compare their space and time complexities.	4	Ana	16
5.	Describe topological sorting of a Directed Acyclic Graph (DAG). Explain the algorithm with example.	4	Ana	16
6.	Explain Dijkstra’s algorithm to find the shortest path from a source to all other vertices. Illustrate with example.	4	Ana	16

7.	Analyze the role of IPsec in providing secure end-to-end communication.	4	Ana	16
8.	Design a secure email communication model for a corporate organization using S/MIME and IPsec.	4	Cre	16

UNIT V

HASHING AND HEAPS

Hash functions, open hashing-separate chaining, closed hashing - linear probing, quadratic probing, double hashing, random probing, rehashing, extendible hashing, Applications – Dictionary Telephone directory Heaps - Heap sort, Applications -Priority Queue using Heaps AVL trees – Terminology – basic operations(rotation, insertion and deletion)

Q.No	Question	CO	BTL	Marks

PART A

1.	Define hash function.	5	Rem	2
2.	State the importance of separate chaining in open hashing.	5	Und	2

3.	Define quadratic probing.	5	Und	2
4.	Define rehashing with an example.	5	Und	2
5.	Mention two applications of hashing.	5	Und	2
6.	List the advantages of heaps in implementing priority queues.	5	Und	2
7.	Define min-heap and max-heap.	5	Und	2
8.	Mention a real-time application of AVL trees.	5	Rem	2
9.	Define rotation in AVL trees.	5	Und	2
10.	Mention one use case for heaps in scheduling.	5	Rem	2
11.	List the basic operations performed in AVL tree	5	Und	2
12.	List the types of rotations in AVL trees.	5	Und	2
13.	State the height balancing condition in AVL trees.	5	Und	2
14.	Define load factor in hashing.	5	Rem	2
15.	How does extendible hashing manage large data sets?	5	Und	2

PART B

1.	What is hashing? Differentiate between open and closed hashing with suitable examples.	5	Und	16
2.	Compare linear probing, quadratic probing, and double hashing in terms of collision resolution and performance.	5	App	16
3.	Explain rehashing and extendible hashing. How do they address hash table overflow?	5	App	16
4.	Explain heap sort algorithm and implement it using a max-heap in Python.	5	Ana	16

5.	Describe how heaps can be used to implement priority queues. List their advantages.	5	Und	16
6.	Explain AVL tree rotations – single and double. Illustrate left-right and right-left cases with diagrams.	5	Ana	16
7.	i) Explain the working of the Heap Sort algorithm with a neat diagram i) Analyze the time and space complexity of Heap Sort in best, average, and worst cases	5	Ana	8 8

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24AIPC303
FUNDAMENTALS OF DATA SCIENCE

UNIT 1

INTRODUCTION TO DATA SCIENCE AND ANALYTICS

Data Science: What - Why - Data Science vs Data Analytics vs Business Intelligence – Types of Data Analytics: Descriptive Analytics - Diagnostic Analytics - Predictive Analytics - Prescriptive Analytics. - Applications of Data Science - Data Science Life Cycle - Tools and Technologies Used

PART - A

Q.NO	QUESTION	CO	BTL	MARK
1.	What is data science?	1	Rem	2
2.	What is the main goal of Data Science?	1	Rem	2
3.	Name the types of data analytics.	1	Rem	2
4.	Mention some of the data science tools used for data visualization.	1	Rem	2
5.	What is Business Intelligence (BI)?	1	Rem	2
6.	List all stages in the data science lifecycle.	1	Rem	2
7.	Name two popular programming languages used in Data Science.	1	Rem	2
8.	Explain the difference between data science and data analytics.	1	Und	2
9.	Why is prescriptive analytics important?	1	Und	2
10.	What is the role of data visualization in data science?	1	Und	2
11.	Describe one real-world application of data science.	1	Und	2
12.	Why is data science important in modern industries?	1	Und	2
13.	Why is Python considered a superior tool for data science compared to other tools?	1	Und	2
14.	Identify two applications of data science in education.	1	Und	2
15.	How does business intelligence differ from data analytics?	1	Und	2

PART – B

1.	Illustrate the Data Science Life Cycle with a neat diagram and explain each phase.	1	Und	16
2.	Explain the various types of data analytics and their role in decision-making processes.	1	Und	16
3.	Given the following dataset structure, identify and explain which type(s) of data analytics would be most appropriate to apply. Justify your reasoning with examples. **Dataset Description:** You are provided with data from a local retail store that contains the following fields: • Transaction_ID • Date of purchase • Customer age and gender • Item purchased • Item category (e.g., groceries, clothing, electronics) • Quantity purchased • Unit price • Payment mode (cash, card, UPI) • Customer feedback (1–5 rating)	1	App	16
4	Apply each type of data analytics (Descriptive, Diagnostic, Predictive and Prescriptive) to a real-world retail business scenario and explain how they can help improve decision-making.	1	App	16
5.	Categorize different types of data analytics and justify their relevance in the healthcare industry.	1	Ana	16
6.	Compare Python and Microsoft Excel tool used in data science based on different aspects and conclude.	1	Ana	16
7.	Evaluate a real-world scenario where the application of predictive analytics failed.	1	Eva	16
8.	Assess the role of data visualization in enhancing understanding during the data science process.	1	Eva	16

UNIT 2
PROBABILITY AND STATISTICS

Probability: Introduction - Random experiment - sample space - Event and it's types - Probability Distribution – Types of Probability - Descriptive Statistics : Estimates of location and variability – Inferential Statistics : Confidence interval - Hypothesis Testing – Z-test

PART - A

Q.NO	QUESTION	CO	BTL	MARK
1.	What is probability.	2	Rem	2
2.	What is a random experiment?	2	Rem	2
3.	What is an event in probability?	2	Rem	2
4.	What is probability distribution.	2	Rem	2
5.	What is mode in a dataset?	2	Rem	2
6.	What is standard deviation.	2	Rem	2
7.	What is mean in descriptive statistics.	2	Rem	2
8.	What is a confidence interval?	2	Rem	2
9.	Explain the concept of sample space with a coin toss experiment.	2	Und	2
10.	Why is standard deviation considered a better measure of dispersion than range?	2	Und	2
11.	What is the role of hypothesis testing in statistics?	2	Und	2
12.	How do estimates of location help in summarizing data?	2	Und	2
13.	How is the mean affected by outliers?	2	Und	2
14.	What is the importance of probability in daily life scenarios?	2	Und	2
15.	Why is the null hypothesis important in hypothesis testing?	2	Und	2

PART – B

1.	Explain the differences between descriptive and inferential statistics with examples.	2	Und	16
2.	Describe the different types of events in probability with real-world examples.	2	Und	16
3.	Compute the mean, median, mode, range and standard deviation using descriptive statistics for the give data. data = [2, 4, 4, 4, 6, 8, 10]	2	App	16
4.	Construct the sample space for tossing two dice and derive the probability distribution for the sum of the outcomes.	2	App	16
5.	Compare and contrast the different measures of variability and discuss their importance.	2	Ana	16
6.	Analyze a real-world scenario where inferential statistics is used to make decisions from limited data.	2	Ana	16
7.	Evaluate the effectiveness of confidence intervals in making statistical decisions. Use examples to support your answer.	2	Eva	16
8.	Justify the use of descriptive statistics in summarizing large datasets using a case study.	2	Eva	16

UNIT 3
PYTHON FOR DATA SCIENCE

Working with NumPy: Array - Basic Array Operations - Basic Mathematical Operations - Pandas: DataFrame - Processing Different File Format - Basic Operations in DataFrame - Combining Multiple Tables - SciPy: Probability and Statistical Operations - Scikit-learn

PART - A

Q.NO	QUESTION	CO	BTL	MARK
1.	Define an array in NumPy.	3	Rem	2
2.	How do you download and import the NumPy library in Python?	3	Rem	2
3.	What function is used to create a 1D NumPy array?	3	Rem	2
4.	Mention any two mathematical operations available in NumPy.	3	Rem	2
5.	What is the use of pandas in Python?	3	Rem	2
6.	Define a DataFrame in pandas.	3	Rem	2
7.	How do you download and import the Scikit-learn library in Python?	3	Rem	2
8.	Mention few function used for statistical calculations in SciPy.	3	Rem	2
9.	Explain the role of NumPy in scientific computing.	3	Und	2
10.	Explain what happens when two arrays of different shapes are added.	3	Und	2
11.	How does a DataFrame differ from a NumPy array?	3	Und	2
12.	Describe how to select a single column from a pandas DataFrame.	3	Und	2
13.	What is the use of read_csv() method in pandas?	3	Und	2
14.	Explain how drop() works in pandas DataFrame.	3	Und	2
15.	What does combining tables mean in pandas and why is it useful?	3	Und	2

PART – B

1.	Explain the structure and purpose of NumPy arrays. How do they differ from Python lists?	3	Und	16
2.	Describe the basic operations that can be performed on a Pandas DataFrame with suitable examples.	3	Und	16
3.	Apply NumPy to create a one-dimensional and two-dimensional array. Demonstrate at least five array operations.	3	App	16
4.	Demonstrate how to merge and join multiple tables using Pandas DataFrame with appropriate examples.	3	App	16
5.	Analyze a small dataset using SciPy statistical functions. Interpret the outcomes.	3	Ana	16
6.	Analyze the impact of handling different file formats efficiently in data preprocessing using Pandas.	3	Ana	16
7.	Evaluate the scalability of Pandas when working with big data. How can limitations be mitigated through optimization techniques or alternative tools?	3	Eva	16
8.	Critically assess the importance of combining multiple tables in a relational format using Pandas. How does this benefit real-world applications like healthcare or e-commerce?	3	Eva	16

UNIT 4
DATA COLLECTION AND CLEANING

Data Collection: Surveys - Web Scraping - API's - Data Cleaning: Quality Checks, Missing Values and Records.

PART - A

Q.NO	QUESTION	CO	BTL	MARK
1.	Define data collection.	4	Rem	2
2.	What is a survey in data collection?	4	Rem	2
3.	What is an API?	4	Rem	2
4.	Define web scraping.	4	Rem	2
5.	Recall the purpose of data collection in data science.	4	Rem	2
6.	State one reason why web scraping is used.	4	Rem	2
7.	What is the role of a data analyst in data cleaning?	4	Rem	2
8.	Describe the impact of poor data quality on analysis.	4	Und	2
9.	Describe how data from surveys can be stored for analysis.	4	Und	2
10.	Explain why accurate data collection is important in data science.	4	Und	2
11.	Describe the use of the dropna() method in handling missing data.	4	Und	2
12.	Explain the impact of incorrect data entries in a dataset.	4	Und	2
13.	Describe how to use fillna() to manage missing values.	4	Und	2
14.	Explain the use of the isnull() method in Python.	4	Und	2
15.	Explain how API authentication works in data access.	4	Und	2

PART – B

1.	Explain the process of data collection using surveys with suitable examples.	4	Und	16
2.	Explain common quality checks performed during data cleaning.	4	Und	16
3.	Apply web scraping techniques to collect data from a public website using the BeautifulSoup library. Describe the steps involved in the process.	4	App	16
4.	Use Python's pandas library to identify and remove duplicate rows from a dataset. Explain the steps involved.	4	App	16
5.	Identify the reasons for missing values in datasets and suggest effective solutions for data imputation or removal.	4	Ana	16
6.	Assess the challenges of using API rate limits and authentication in real-world applications.	4	Ana	16
7.	Justify the choice of a specific data cleaning strategy based on the characteristics of a given dataset.	4	Eva	16
8.	Evaluate the advantages and limitations of manual versus automated data collection techniques in terms of efficiency, accuracy and scalability.	4	Eva	16

UNIT 5
DATA TRANSFORMATION

Normalization : Min Max Scaling - Standardization - Discretization - Generalization - Attribution Construction - Encoding Categorical Variables : Label – One-Hot - Aggregation - Smoothing.

PART – A

Q.NO	QUESTION	CO	BTL	MARK
1.	What is normalization in data preprocessing?	5	Rem	2
2.	Mention two encoding techniques used for categorical variables.	5	Rem	2
3.	Define label encoding.	5	Rem	2
4.	What is one-hot encoding?	5	Rem	2
5.	Define aggregation in data preprocessing.	5	Rem	2
6.	What is smoothing?	5	Rem	2
7.	What is the range of min-max normalized data?	5	Rem	2
8.	What type of data is suitable for one-hot encoding?	5	Rem	2
9.	How does generalization help reduce the complexity of data?	5	Und	2
10.	What is the effect of Min-Max normalization on outliers?	5	Und	2
11.	When should standardization be preferred over normalization?	5	Und	2
12.	Define the purpose of using scaling techniques in machine learning.	5	Und	2
13.	How does attribute construction help improve model accuracy?	5	Und	2
14.	What is attribute construction in the context of data preprocessing?	5	Und	2
15.	Describe one method used for discretizing continuous data.	5	Und	2

PART – B

1.	Describe how standardization transforms data. Why is it important in machine learning?	5	Und	16
2.	Explain how categorical variables are handled using encoding techniques.	5	Und	16

3.	Apply Min-Max Scaling to a dataset with given sample values (Mark 1 & Mark 2). Show all steps.	5	App	16

Student	Mark_1	Mark_2
A	45	53
B	75	61
C	85	91
D	90	84
E	64	79

4.	Construct new features using attribute construction based on provided raw data.	5	App	16

Student	**Birth_Year**	**Score_Math**	**Score_English**
A	2005	85	78
B	2006	90	88
C	2004	72	65
D	2005	60	70
E	2007	95	92

5.	Given a noisy time series dataset, apply and analyze the results of smoothing using Moving Average method.	5	Ana	16

Time(Day)	**Sales(Units)**
1	120
2	130
3	115
4	140
5	150
6	160
7	145
8	170
9	165
10	175

6.	Examine the difference between generalization and discretization with suitable examples and use cases.	5	Ana	16
7.	Evaluate the role of generalization in simplifying complex datasets while preserving essential patterns. Provide suitable examples and explain.	5	Eva	16
8.	Assess how data preprocessing errors (e.g., incorrect encoding or missing scaling) can affect downstream machine learning tasks.	5	Eva	16

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AD3461

ARTIFICIAL INTELLIGENCE

UNIT I

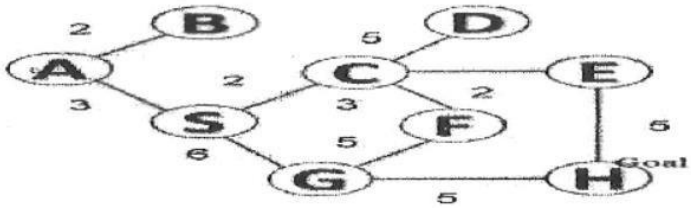
I N T E L L I G E N T A G E N T

Introduction to AI – Agents and Environments – Concept of Rationality – Nature of Environments – Structure of Agents – Problem Solving Agents – Search Algorithms – Uninformed Search Strategies

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define Artificial Intelligence (AI).	1	Rem	2
2.	What is the role of agent program?	1	Rem	2
3.	What is an agent function? Differentiate an agent function and an agent program.	1	Rem	2
4.	What is meant by Turing test?	1	Rem	2
5.	State the concept of rationality.	1	Rem	2
6.	Give the structure of agent in an environment.	1	Rem	2
7.	List some of the uninformed search techniques.	1	Rem	2
8.	List down the characteristics of intelligent agent.	1	Und	2
9.	What are the factors that a rational agent should depend on at any given time?	1	Und	2

10.	Differentiate between Intelligence and Artificial Intelligence.	1	Und	2
11.	List the various informed search strategies.	1	Und	2
12.	Compare Deterministic vs Stochastic environment.	1	Und	2
13.	Give PEAS description for Part picking robot.	1	Und	2
14.	Give performance evaluation measure for BFS, DFS, UCs, IDDFS, DLS.	1	Und	2
15.	Formulate PEAS for an automated taxi driver.	1	Und	2

PART B

1.	Explain the structure of a typical intelligent agent with an example. Discuss how the structure influences the agent's performance.	1	App	16
2.	Perform BFS, DFS, Uniform Cost Search strategies on the following graph and also formulate the algorithm. 	1	App	16
3.	Explain the concept of rationality in AI agents and analyze how it affects their decision-making process in uncertain environments.	1	App	16
4.	Describe the structure of a Goal-Based Agent and explain how it differs from a simple reflex agent. Analyze the implications of these differences in a dynamic environment.	1	App	16
5.	Describe the components necessary to define a problem in AI and discuss how each component contribute to the problem-solving process.	1	App	16
6.	Describe the PAES representation for an automated taxi driver, an ATM system, and a medical diagnosis system. Explain each component in the context of the agents.	1	Ana	16
7.	What is informed search technique? Explain any two in detail.	1	Ana	16
8.	Explain in detail the uninformed search strategies: Depth-First Search (DFS), Iterative Deepening Depth-First Search (IDDFS), and Depth-Limited Search (DLS). Discuss their methodologies, applications, and limitations.	1	Ana	16

UNIT II

PROBLEM SOLVING

Informed (Heuristic) Search Strategies – Heuristic Functions – Local search and optimization problems – Local search in continuous space – Search with non-deterministic actions – Search in partially observable environments – Online search agents and unknown environments.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Compare the Greedy BFS and Recursive BFS	2	Rem	2
2.	Explain the Global minimum and Global maximum.	2	Rem	2
3.	Define annealing.	2	Rem	2
4.	What is an online search agent?	2	Rem	2
5.	Give the procedure of IDA* search and A* search.	2	Rem	2
6.	What is heuristic search strategy?	2	Rem	2
7.	What is Heuristic Function? and define the effect of heuristic accuracy on performance.	2	Und	2
8.	Compare the admissible and dominant heuristics.	2	Und	2

9.	What do you mean by local maxima with respect to search technique.	2	Und	2
10.	Define Hill climbing search.	2	Und	2
11.	State the reason when hill climbing often gets stuck.	2	Und	2
12.	What is the purpose of a contingency plan?	2	Und	2
13.	Compare and contrast admissible and consistent heuristics.	2	Und	2
14.	Illustrate the non-deterministic and partially observable environment	2	Und	2
15.	What are the component that agents know in online search problem?	2	Und	2

PART B

1.	Explain the working of hill climbing algorithm and explain the types of hill climbing techniques with suitable example.	2	App	16
2.	Explain various local search algorithm in detail.	2	App	16
3.	Explain various informed or heuristic search technique in detail.	2	App	16
4.	Explain how you would implement a heuristic function for a specific problem, such as the 8-puzzle problem.	2	App	16
5.	Analyze the Greedy BFS and Recursive BFS with suitable example in detail and discuss the Online Search Agents that uses depth-first exploration.	2	App	16
6.	Illustrate in detail about A* algorithm with suitable example and Explain the types of hill climbing techniques	2	App	16
7.	Explain how searching is done in non-deterministic and partially observable environment	2	Und	16
8.	What is heuristic search technique in AI? How does heuristics search works? Explain its advantages and disadvantages. Describe the local search algorithm with neat sketch .	2	Ana	16

UNIT III

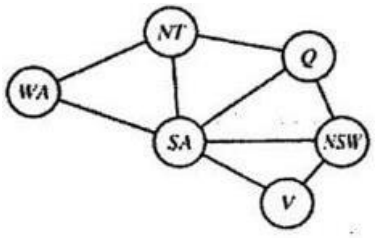
GAME PLAYING AND CSP

Game theory – Optimal decisions in games – Alpha-beta search – Monte-Carlo tree search – stochastic games – Partially observable games – Constraint Satisfaction Problems – Constraint Propagation – Backtracking search for CSP – Local Search for CSP – Structure of CSP.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is minmax algorithm?	3	Rem	2
2.	What is alpha beta pruning?	3	Rem	2
3.	What is constraint satisfaction Problem and list the types of constraints in CSP.	3	Rem	2
4.	Define forward checking and backtracking in CSP.	3	Rem	2

5.	Give applications of game theory.	3	Rem	2
6.	What are stochastic games?	3	Rem	2
7.	How alpha beta pruning overcome the drawback of minmax algorithm?	3	Rem	2
8.	What do you mean by constrain propagation?	3	Und	2
9.	List the types of assignments in CSP and how do we represent the structure of problems in CSP.	3	Und	2
10.	Define Cycle Cutset	3	Und	2
11.	Define Tree Decomposition.	3	Und	2
12.	How can mini max also be extended for game of chance.	3	Und	2
13.	Justify why we cannot use traditional minmax for games with an element of chance, such as backgammon.	3	Und	2
14.	Write the components of a game.	3	Und	2
15.	List the types of assignments in CSP.	3	Und	2

PART B

1.	Apply the Constraint Satisfaction Problem and constraint propagation for solving cryptoaritmetic problem and map-coloring problem Consider the map coloring problem with 6 variables and three colors (red, green, blue). The constraint graph for the problem is given below. How does backtracking search solve the given problem? What are the heuristics used to improve the efficiency of the search? How are failures detected early in backtracking? Can Breadth First Search be applied to the above problem? State reasons for your answer.	3	App	16
2.		3	App	16
3.	Explain minmax game playing algorithm in detail with suitable example	3	App	16
4.	Explain alpha beta pruning in detail with an example. (16)	3	App	16

5.	What are partially observable games? How are they solved in a deterministic environment?	3	Ana	16
6.	i. Write short notes on Monte-Carlo search. ii. Define local consistency. What are the different types of local consistency? Explain any two.	3	Ana	8 8
7.	i. Analyze how alpha beta search algorithm differs from Minmax algorithm. ii. Explain the concept of game theory and its role in artificial intelligence. Discuss the process of making optimal decisions in games with suitable example.	3	Ana	8 8
8.	What are stochastic games? Explain their characteristics and strategies for decision-making with examples.	3	Ana	16

UNIT IV

LOGICAL AGENTS

Knowledge-based agents – Propositional logic – Propositional theorem proving – Propositional model checking – Agents based on propositional logic – First-order logic – Syntax and semantics – Knowledge representation and engineering – Inferences in first-order logic – Forward chaining – Backward chaining – Resolution.

Q.No	Question	CO	BTL	Marks

PART A

1.	What is a Knowledge-Based Agent? What are the three levels in describing knowledge-based agent?	4	Und	2
2.	What are the limitations in using propositional logic to represent a knowledge base?	4	Und	2

3.	Define first-order definite clause, “Some people like every vegetable”. Convert it to First order logic.	4	Rem	2
4.	State the generalized modus ponens.	4	Rem	2
5.	What is Skolemisation?	4	Rem	2
6.	List various inference rules in propositional logic and predicate logic	4	Rem	2
7.	What is resolution?	4	Und	2
8.	Give the grammar to represent propositional logic and predicate logic.	4	Und	2
9.	Compare the propositional logic and predicate logic.	4	Und	2
10.	Differentiate forward and backward chaining.	4	Und	2
11.	Represent the following sentence in predicate form: "All the children like sweets."	4	Und	2
12.	Define causal and diagnostic rules with an example.	4	Und	2
13.	What factors justify whether reasoning is to be done in forward or backward reasoning?	4	Und	2
14.	State the converse and contrapositive of the statement “when I stay up late, it is necessary that I sleep until noon”.	4	Und	2
15.	Define the terms belief state and state estimation.	4	Und	2

PART B

1.	During a murder investigation, you have gathered some clues. Express them as propositions and solve the following scenario using laws of inference. The clues gathered are given below: • If the knife is in the store room, then we saw it when we cleared the store room. • The murder was committed at the basement or inside the apartment. • If the murder was committed at the basement, then the knife is in the yellow dust bin. • We did not see a knife when we cleared the store room. • If the murder was committed outside the building, then we are unable to find the knife. • If the murder was committed inside the apartment, then the knife is in the store room. Find: “Where is the knife?”.	4	App	16
2.	i. Brief on the concept of resolution and explain the	4	App	8

	propositional resolution algorithm. (7) ii. Prove the following axioms using the resolution algorithm. (9) • All hounds how! At night. • Anyone who has any cats will not have any mice. • Light sleepers do not have anything which howls at night. • John has either a cat or a bound. • (conclusion) If John is a light sleeper, then John does not have any mice.			8
	Give the rules of inference in propositional logic. (9) Which rule of inference is used in each argument below? (7) Alice is a Math major and a CSI major. Therefore, Jerry is a math major. Jerry is a Math major and a CSI major. Therefore, Jerry is a math major.		App	
3.	If it is rainy, then the pool will be closed. It is rainy. Therefore, the pool is closed. If it snows today, the university will close. The university is not closed today. Therefore, it did not snow today. If I go swimming, then I will stay in the sun too long. If I stay in the sun too long, then I will sunburn. Therefore, if I go swimming, then I will sunburn.	4		16
4.	Describe forward chaining and backward chaining algorithms in detail. Apply both the algorithms to prove that "West is a Criminal."	4	App	16
5.	Discuss the Knowledge Engineering Process with proper illustration. Depict the concept of forward chaining.	4	Ana	16
6.	i. Explain standard quantifiers of first-order logic with examples. (9) ii. Give the five logical connectives used to construct complex sentences and give the formal grammar of propositional logic. (7)	4	Ana	8 8
7.	Explain inferencing process in first order predicate logic. Apply both the algorithm to prove that "West is Criminal".	4	Ana	16
8.	i. Discuss the propositional theorem proving in detail. (6) ii. Explain the knowledge-based agents in detail with neat sketch. (10)	4	Ana	8 8

UNIT V

KNOWLEDGE REPRESENTATION AND PLANNING

Acting under uncertainty Bayesian inference naïve Bayes models. Probabilistic reasoning Bayesian networks - exact inference in BN-approximate Inference in BN-causal networks.

Q.No	Question	CO	BTL	Marks

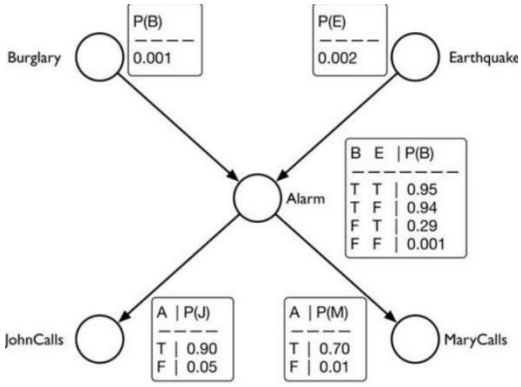
PART A

1.	Define Dampster-Shafer theory.	5	Rem	2
2.	Define Bayes Theorem and Bayes rule.	5	Rem	2
3.	What is reasoning and define prior probability.	5	Rem	2
4.	State the types of approximation methods.	5	Rem	2
5.	What is causal networks?	5	Rem	2
6.	How are Bayesian networks represented? Write down the purpose of relational probability models?	5	Rem	2
7.	Justify the purpose of Bayesian networks.	5	Und	2
8.	What is the logic used in reasoning with uncertain information.	5	Und	2
9.	State the types of inference in Bayesian network.	5	Und	2
10.	Why does probabilistic reasoning necessary in AI?	5	Und	2
11.	What is Naïve Bayes algorithm.	5	Und	2
12.	What is the relationship between probability distribution and Bayesian Network?	5	Und	2
13.	What is meant by Joint probability and conditional probability.	5	Und	2
14.	List the components of a Bayesian Network and list some applications of Bayes' theorem.	5	Und	2
15.	What type of graph is used to represent a Bayesian Network?	5	Und	2

PART B

1.	Define uncertain knowledge, prior probability and conditional probability. State Bayes theorem. How is it useful for decision making under uncertainty. Explain belief network briefly.	5	App	16
2.	Explain in detail about Bayesian Inference and describe the Bayesian network in detail.	5	App	16
3.	You have a new burglar alarm installed at home. It is fairly reliable at detecting a burglary, but also responds on occasion to minor earthquakes. You also have two neighbors, Joh and Mary, who have promised to call you at work when they hear the alarm. John nearly always calls when he hears the alarm, but sometimes confuses the telephone ringing with the alarm and calls then, too, Mary, on the	5	App	16

other hand, likes rather loud music and often misses the alarm altogether. The Bayesian network and the conditional probability table (CPT) for the scenario is given below. In the CPTs, the letters B, E, A, J, and M stand for Burglary, earthquake, Alarm, John Calls and Mary calls, respectively. From the Bayesian network, find P (B/J, M) using variable elimination. (16)



4. Explain in detail Naïve Bayes algorithm with example is given below: App 5 16

Suppose we have a dataset of weather conditions and corresponding target variable "Play". So, using this dataset we need to decide that whether we should play or not on a particular day according to the weather conditions.

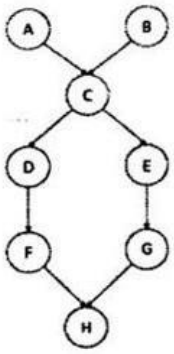
	Outlook	Play
0	Rainy	Yes
1	Sunny	Yes
2	Overcast	Yes
3	Overcast	Yes
4	Sunny	No
5	Rainy	Yes
6	Sunny	Yes
7	Overcast	Yes
8	Rainy	No
9	Sunny	No
10	Sunny	Yes
11	Rainy	No
12	Overcast	Yes
13	Overcast	Yes

5. i. Consider there are 3 Boolean variables toothache, catch and cavity. From the full joint distribution given below, calculate the following: (9) 5 8 8

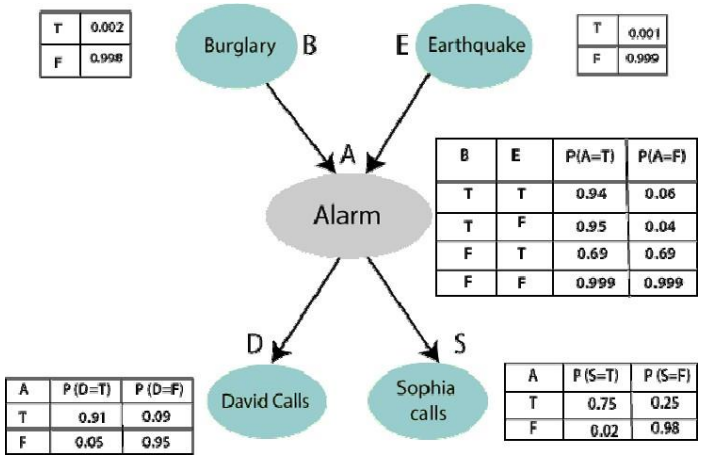
	toothache		¬toothache	
	catch	*¬catch*	*catch*	*¬catch*
cavity	0.108	0.012	0.072	0.008
¬cavity	0.016	0.064	0.144	0.576

(1) P (toothache)
(2) P (Cavity)
(3) P (Toothache | Cavity)
(4) P (Cavity | toothache v catch) App

ii. What is d-separation? Where are two nodes d-separated? From the Bayesian network given below, find whether D and E d-separated given evidence about both A and B? State reasons for your answer. (7)



6. What is Bayesian network? Explain the method for constructing Bayesian networks and calculate the probability that alarm has sounded, but there is neither a burglary, nor an earthquake occurred, and David and Sophia both called the Harry. App 5 16



7.	Explain the method of performing exact inference and approximate inference in detail.	5	Ana	16
8.	Illustrate in detail about causal network and explain how to represent knowledge in an uncertain domain.	5	Ana	16

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