# COMPUTER SCIENCE & ENGINEERING

# QUESTION BANK

**Course Title:** DISCRETE MATHEMATICS
**Course Code:** 25CS301
**Regulation:** NR25

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# COURSE OBJECTIVES

- Introduces elementary discrete mathematics for Computer Science and Engineering.
- Topics include formal logic notation, methods of proof, induction, sets, relations, graph theory, permutations and combinations, counting principles, recurrence relations and generating functions.

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# COURSE OUTCOMES

- **CO1:** Ability to understand and construct precise mathematical proofs.
- **CO2:** Ability to use logic and set theory to formulate precise statements.
- **CO3:** Ability to analyze and solve counting problems on finite and discrete structures.
- **CO4:** Ability to describe and manipulate sequences.
- **CO5:** Ability to apply graph theory in solving computing problems.

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# UNIT – II

## SET THEORY

**Syllabus:** Introduction, Basic Concepts of Set Theory, Representation of Discrete Structures, Relations and Ordering, Functions.

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# PART – A

## SHORT ANSWER QUESTIONS

| S.No. | Questions | BT | CO | PO |
|---|---|---|---|---|
| 1 | Define a set, subset, power set and cardinality of a set with suitable examples. | L1 | CO2 | PO1 |
| 2 | Define a universal set and complement of a set with suitable examples. | L1 | CO2 | PO1 |
| 3 | For the sets $P = \{a, b, c, d\}$, $Q = \{c, d, e, f, g\}$, and $R = \{c, e, h\}$, find $(P \cup Q) \cap R$ and $P - (Q \cap R)$. | L3 | CO2 | PO2 |
| 4 | State and explain the basic laws of set theory. | L2 | CO2 | PO1 |
| 5 | Define a relation from a set $A$ to a set $B$ and give a suitable example. | L1 | CO2 | PO1 |
| 6 | Define an equivalence relation and give a suitable example. | L1 | CO2 | PO1 |
| 7 | Define a partial ordering relation and give a suitable example. | L1 | CO2 | PO1 |
| 8 | Define a partially ordered set (Poset). Give an example. | L1 | CO2 | PO1 |
| 9 | Define a function from $A$ to $B$. Distinguish between domain, codomain and range. | L1 | CO2 | PO1 |
| 10 | Determine whether each of the following relations is a function: $f = \{(1,3),(2,3),(3,1)\}$, $g = \{(1,2),(3,1)\}$, and $h = \{(1,3),(2,1),(1,2),(3,1)\}$, where the domain is $A = \{1,2,3\}$. | L3 | CO2 | PO2 |
| 11 | Define one-to-one and onto functions with suitable examples. | L1 | CO2 | PO1 |
| 12 | Define the composition of two functions and write its notation. | L1 | CO2 | PO1 |
| 13 | What is a Hasse diagram? State the basic rules for constructing a Hasse diagram. | L2 | CO2 | PO1 |
| 14 | Define reflexive, symmetric, antisymmetric and transitive relations. | L1 | CO2 | PO1 |
| 15 | What is an equivalence class? Give a suitable example. | L1 | CO2 | PO1 |
| 16 | Define the inverse of a relation and give a suitable example. | L1 | CO2 | PO1 |

# PART – B

## LONG ANSWER QUESTIONS

| S.No. | Questions | BT | CO | PO |
|---|---|---|---|---|
| 17 | Let $A = \{1, 2, 3, 4, 6\}$ and $R$ be a relation on $A$ defined by $aRb$ if and only if $a$ is a multiple of $b$. Represent $R$ as a matrix and draw its directed graph. | L3 | CO2 | PO2 |
| 18 | Let $A = \{a, b, c, d\}$ and let $R$ be a relation on $A$ represented by the matrix $$M_R = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$ Construct the directed graph of $R$ and determine the in-degree and out-degree of each vertex. | L3 | CO2 | PO2 |
| 19 | Let $A = \{1, 2, 3\}$ and $R = \{(1, 1), (2, 2), (3, 3)\}$. Verify whether $R$ is an equivalence relation. | L4 | CO2 | PO2 |
| 20 | Let $A = \{1, 2, 3, 4, 6, 8, 12\}$ and define a partial ordering relation $R$ on $A$ by $aRb$ if and only if $a$ divides $b$. (a) Draw the Hasse diagram of $R$. (b) Write the relation matrix of $R$. | L3 | CO2 | PO2 |
| 21 | Let $A = \{1, 2, 3, 4, 5\}$ and $R = \{(1, 1), (2, 2), (3, 3), (1, 3), (3, 4), (3, 5), (1, 4), (4, 4), (1, 5), (2, 3), (2, 4), (2, 5), (5, 5)\}$. Determine whether $R$ is a partial ordering relation. If it is, draw its Hasse diagram. | L4 | CO2 | PO2 |
| 22 | Draw the Hasse diagrams of the following sets under the partial ordering relation "divides" and identify which of them are totally ordered: (a) $\{2, 6, 24\}$, (b) $\{3, 5, 15\}$, (c) $\{1, 2, 3, 6, 12\}$, (d) $\{2, 4, 8, 16\}$, (e) $\{3, 9, 27, 54\}$. | L4 | CO2 | PO2 |
| 23 | Let $D_{100} = \{1, 2, 4, 5, 10, 20, 25, 50, 100\}$ be the set of divisors of 100. Draw the Hasse diagram of $(D_{100}, \mid)$, where $\mid$ denotes the divisibility relation. Find: (i) $glb\{10, 20\}$, (ii) $lub\{10, 20\}$, (iii) $glb\{5, 10, 20, 25\}$, and (iv) $lub\{5, 10, 20, 25\}$. | L4 | CO2 | PO2 |
| 24 | Let $f, g : \mathbb{R} \to \mathbb{R}$ be defined by $f(x) = ax + b$ and $g(x) = 1 - x + x^2$. If $(g \circ f)(x) = 9x^2 - 9x + 3$, determine $a$ and $b$. | L3 | CO2 | PO2 |
| 25 | Let $f : A \to B$ and $g : B \to C$ be functions. Prove that if $f$ and $g$ are one-to-one, then $g \circ f$ is one-to-one. | L4 | CO2 | PO2 |
| 26 | Let $f : A \to B$ and $g : B \to C$ be functions. Prove that if $f$ and $g$ are onto, then $g \circ f$ is onto. | L4 | CO2 | PO2 |
| 27 | For the sets $A = \{1, 2, 3, 4\}$ and $B = \{a, b, c\}$, determine the number of functions from $A$ to $B$, the number of one-to-one functions from $A$ to $B$, and the number of onto functions from $A$ to $B$. | L3 | CO2 | PO2 |

| S.No. | Questions | BT | CO | PO |
|---|---|---|---|---|
| 28 | Let $A = \{1, 2, 3, 4\}$ and define a relation $R$ on $A$ by $aRb$ if and only if $a - b$ is divisible by 2. Verify that $R$ is an equivalence relation and determine the equivalence classes. | L4 | CO2 | PO2 |
| 29 | Let $A = \{1, 2, 3, 4, 5, 6\}$ and define $R$ by $aRb$ if and only if $a \leq b$. Determine whether $R$ is reflexive, symmetric, antisymmetric and transitive. Hence determine whether $R$ is a partial ordering relation. | L4 | CO2 | PO2 |
| 30 | Given $A = \{1, 2, 3\}$ and $B = \{a, b, c, d\}$, determine all possible relations from $A$ to $B$. Also find the total number of such relations. | L3 | CO2 | PO2 |
| 31 | For $P = \{1, 2, 3, 4\}$, $Q = \{3, 4, 5, 6\}$, and $R = \{4, 5, 6, 7\}$, verify the distributive laws of sets: $P \cap (Q \cup R) = (P \cap Q) \cup (P \cap R)$ and $P \cup (Q \cap R) = (P \cup Q) \cap (P \cup R)$. | L4 | CO2 | PO2 |
| 32 | Let $A = \{1, 2, 3, 4, 5\}$. Define $R = \{(a, b) : a \leq b\}$. Represent $R$ using a matrix and directed graph. Verify whether $R$ is a partial order. | L4 | CO2 | PO2 |

# BLOOM'S TAXONOMY LEVELS (BT)

| Level | Bloom's Taxonomy | Description |
|---|---|---|
| **L1** | Remembering | Define, State, List, Identify, Recall |
| **L2** | Understanding | Explain, Describe, Interpret, Classify, Summarize |
| **L3** | Applying | Solve, Calculate, Construct, Demonstrate, Use |
| **L4** | Analyzing | Analyze, Differentiate, Examine, Compare, Verify |
| **L5** | Evaluating | Justify, Critique, Verify, Assess, Validate |
| **L6** | Creating | Design, Formulate, Construct, Develop, Generate |

# CO–PO ALIGNMENT FOR UNIT-II

### CO2

**Ability to use logic and set theory to formulate precise statements.**

Unit-II questions primarily assess the ability to:

- Understand and manipulate sets.
- Perform set operations.
- Represent discrete structures.
- Define and analyze relations.

• Determine properties of relations.
• Represent relations using matrices and directed graphs.
• Understand equivalence relations.
• Understand partial ordering relations.
• Construct and interpret Hasse diagrams.
• Understand functions and their properties.
• Determine composition of functions.
• Analyze one-to-one and onto functions.

### PO MAPPING

**PO1 – Engineering Knowledge:**
Apply mathematical and set-theoretic concepts to solve problems in Computer Science and Engineering.

**PO2 – Problem Analysis:**
Identify, formulate and analyze discrete structures, relations and functions using appropriate mathematical principles.

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# UNIT-II TOPIC-WISE COVERAGE

| Unit-II Topic | Question Numbers |
|---|---|
| Basic Concepts of Set Theory | 1, 2, 3, 4, 31 |
| Set Operations | 3, 4, 31 |
| Power Set and Cardinality | 1 |
| Representation of Discrete Structures | 17, 18, 20, 32 |
| Relations | 5, 6, 14, 15, 16, 17, 18, 19, 21, 28, 29, 30, 32 |
| Properties of Relations | 14, 19, 21, 28, 29, 32 |
| Equivalence Relations | 6, 15, 19, 28 |
| Partial Ordering Relations | 7, 8, 13, 20, 21, 22, 23, 29, 32 |
| Hasse Diagrams | 13, 20, 21, 22, 23 |
| Functions | 9, 10, 11, 12, 24, 25, 26, 27 |
| Composition of Functions | 12, 24, 25, 26 |
| One-to-One and Onto Functions | 11, 25, 26, 27 |

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# IMPORTANT CORRECTIONS MADE FROM THE ORIGINAL QUESTION BANK

1. **“Define Poset and distributive lattice”** was corrected because **distributive lattice belongs to Unit-III**, not Unit-II.
2. “Define Poset” is correctly classified as **L1 – Remembering**, not L4.
3. Questions involving calculation of set operations are classified as **L3 – Applying**.
4. Questions involving verification of properties of relations are classified as **L4 – Analyzing**.
5. Questions involving Hasse diagrams are classified as **L3 or L4**, depending on whether the student only constructs the diagram or must analyze the ordering.
6. The function composition problem involving $f(x) = ax + b$ was changed from **L1 to L3**, because the student has to calculate $a$ and $b$.
7. Questions involving relation matrices and directed graphs are classified as **L3**.
8. Equivalence-relation verification questions are classified as **L4** because students must examine reflexivity, symmetry and transitivity.
9. Lattice and distributive-lattice questions from the original Unit-II bank have been excluded because they belong to **Unit-III: Algebraic Structures** according to the syllabus provided.
10. All Unit-II questions are primarily mapped to **CO2**, because CO2 specifically addresses logic and set theory.
11. **PO1 and PO2** are used as the primary PO mappings for Unit-II.

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# RECOMMENDED BT DISTRIBUTION FOR UNIT-II

| BT Level | Main Focus |
|---|---|
| **L1 – Remembering** | Definitions, terminology and basic concepts |
| **L2 – Understanding** | Explanation and interpretation |
| **L3 – Applying** | Set operations, matrices, functions and Hasse diagrams |
| **L4 – Analyzing** | Verification of relations, equivalence, partial orders and function properties |

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# TEXT BOOKS


1. **Discrete Mathematical Structures with Applications to Computer Science** – J. P. Tremblay and R. Manohar, McGraw-Hill, 1st Edition.
2. **Discrete Mathematics for Computer Scientists and Mathematicians** – Joe L. Mott, Abraham Kandel and Theodore P. Baker, Prentice Hall of India, 2nd Edition.

# REFERENCE BOOKS


1. **Discrete and Combinatorial Mathematics – An Applied Introduction** – Ralph P. Grimaldi, Pearson Education, 5th Edition.
2. **Discrete Mathematical Structures** – Thomas Koshy, Tata McGraw-Hill.