COMPUTER SCIENCE & ENGINEERING

QUESTION BANK

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

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.

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.

UNIT – I

MATHEMATICAL LOGIC

Syllabus: Introduction, Statements and Notation, Connectives, Normal Forms, Theory of Inference for the Statement Calculus, The Predicate Calculus, Inference Theory of the Predicate Calculus.

PART – A

SHORT ANSWER QUESTIONS

S.No.	Questions	BT	CO	PO
1	Identify which of the following sentences are propositions: (i) A triangle contains three sides. (ii) $x + 2$ is a positive integer.	L1	CO1	PO1
2	Define a proposition and give two suitable examples.	L1	CO1	PO1
3	Define the principal disjunctive normal form (PDNF) and principal conjunctive normal form (PCNF).	L1	CO1	PO1
4	Write the following statement in symbolic form and find its negation: “All integers are rational numbers and some rational numbers are not integers.”	L3	CO1	PO2
5	State the contrapositive, converse and inverse of the conditional statement: “If the sky is cloudy, then it will rain.”	L2	CO1	PO1
6	State De Morgan's Laws for propositions.	L1	CO1	PO1
7	Define a predicate and give a suitable example.	L1	CO1	PO1
8	Define the disjunction of two propositions and construct its truth table.	L2	CO1	PO1
9	Define logical equivalence and give one example.	L1	CO1	PO1
10	Construct the truth table for $(\neg P \vee \neg Q) \rightarrow (P \leftrightarrow Q)$.	L3	CO1	PO2
11	Define tautology, contradiction and contingency with suitable examples.	L1	CO1	PO1
12	What is a well-formed formula? Give an example.	L1	CO1	PO1
13	Define free and bound variables in predicate logic.	L1	CO1	PO1
14	State the rules of inference Modus Ponens and Modus Tollens.	L1	CO1	PO1
15	What is resolution in propositional logic?	L1	CO1	PO1
16	Distinguish between universal and existential quantifiers with suitable examples.	L2	CO1	PO1

PART – B

LONG ANSWER QUESTIONS

S.No.	Questions	BT	CO	PO
17	Translate the following statements into propositional logic using P: “The message is scanned for viruses” and Q: “The message was sent from an unknown system.” (i) The message is scanned for viruses whenever it was sent from an unknown system. (ii) It is necessary to scan the message for viruses whenever it was sent from an unknown system.	L3	CO1	PO2
18	Prove that $\{(p \to q) \to r\} \leftrightarrow \{(\neg p \vee q) \to r\}$ is a tautology.	L4	CO1	PO2
19	Obtain the Principal Disjunctive Normal Form (PDNF) and Principal Conjunctive Normal Form (PCNF) of $(P \wedge Q) \vee (\neg P \wedge R) \vee (Q \wedge R)$.	L3	CO1	PO2
20	Show that $R \to S$ can be derived from the premises $P \to (Q \to S)$, $\neg R \vee P$, and Q, using suitable rules of inference.	L4	CO1	PO2
21	Explain the following concepts with suitable examples: (i) Normal Forms (ii) Free and Bound Variables (iii) Logical Equivalence (iv) Resolution.	L2	CO1	PO1
22	Show that $(\forall x)(P(x) \to Q(x)) \wedge (\forall x)(Q(x) \to R(x)) \to (\forall x)(P(x) \to R(x))$ is logically valid.	L4	CO1	PO2
23	Consider the statements: “All lions are fierce”, “Some lions do not drink coffee” and “Some fierce creatures do not drink coffee.” Let $P(x)$, $Q(x)$, and $R(x)$ denote “x is a lion”, “x is fierce” and “x drinks coffee”, respectively. Assuming that the domain consists of all creatures, express the statements using quantifiers and $P(x), Q(x), R(x)$.	L3	CO1	PO2
24	Construct the truth tables for: (a) $q \leftrightarrow (\neg p \vee \neg q)$, (b) $[(p \wedge q) \vee \neg r] \leftrightarrow p$.	L3	CO1	PO2
25	Find the Disjunctive Normal Forms of: (a) $(p \vee q \vee \neg q) \wedge (p \vee \neg p)$, (b) $(\neg p \to r) \wedge (p \leftrightarrow q)$.	L3	CO1	PO2
26	Determine whether the argument $(\forall x)(P(x) \vee Q(x)) \to [(\forall x)P(x) \vee (\forall x)Q(x)]$ is valid. If it is not valid, provide a counterexample.	L4	CO1	PO2
27	Give a direct proof, an indirect proof and a proof by contradiction for the statement: “If n is an odd integer, then $n + 11$ is an even integer.”	L4	CO1	PO2
28	Prove De Morgan's Laws using truth tables and explain their significance in simplifying logical expressions.	L3	CO1	PO1
29	Construct the truth table and determine whether $(p \to q) \leftrightarrow (\neg q \to \neg p)$ is a tautology.	L4	CO1	PO2

S.No.	Questions	BT	CO	PO
30	Using suitable rules of inference, determine whether the following argument is valid: "If a student studies Discrete Mathematics, then the student can solve logical problems. Ravi studies Discrete Mathematics. Therefore, Ravi can solve logical problems."	L4	CO1	PO2
31	Translate the following statements into predicate logic and write their negations: (i) Every student has a laptop. (ii) Some student does not have a laptop. (iii) Every programmer knows at least one programming language.	L3	CO1	PO2
32	Prove by contradiction that $\sqrt{2}$ is irrational.	L4	CO1	PO2
33	Using mathematical induction, prove that $1 + 2 + 3 + \cdots + n = \frac{n(n+1)}{2}$ for every positive integer n.	L4	CO1	PO2
34	Explain the Theory of Inference for Statement Calculus and illustrate the use of Modus Ponens, Modus Tollens, Hypothetical Syllogism and Disjunctive Syllogism with suitable examples.	L2	CO1	PO1
35	Convert the proposition $(p \to q) \land (\neg q \to r)$ into an equivalent expression using only $\neg$, $\lor$, and $\land$.	L3	CO1	PO2
36	Analyze the given argument and determine its validity using a truth table: "If it rains, the ground is wet. The ground is not wet. Therefore, it did not rain."	L4	CO1	PO2

BLOOM'S TAXONOMY LEVELS (BT)

Level	Bloom's Taxonomy	Action Verbs
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, Prove
L5	Evaluating	Justify, Critique, Verify, Assess, Validate
L6	Creating	Design, Formulate, Construct, Develop, Generate

CO–PO ALIGNMENT FOR UNIT-I

CO1

Ability to understand and construct precise mathematical proofs.

Unit-I questions primarily assess students' ability to:

- Understand propositions and logical connectives.
- Construct and interpret truth tables.
- Apply rules of inference.
- Formulate statements using propositional and predicate logic.
- Construct normal forms.
- Analyze logical arguments.
- Construct mathematical proofs.

PO MAPPING

PO1 – Engineering Knowledge:
Apply mathematical and logical knowledge to formulate and solve engineering and computing problems.

PO2 – Problem Analysis:
Identify, formulate and analyze logical and mathematical problems using appropriate principles and methods.

UNIT-I TOPIC-WISE COVERAGE

Unit-I Topic	Question Numbers
Statements and Propositions	1, 2
Logical Connectives	5, 6, 8, 11
Truth Tables	10, 24, 28, 29, 36
Tautology and Contradiction	11, 18, 29
Logical Equivalence	9, 18, 29
Normal Forms	3, 19, 21, 25
Rules of Inference	14, 20, 30, 34
Predicate Logic	7, 13, 16, 22, 23, 26, 31
Quantifiers	16, 22, 23, 26, 31
Methods of Proof	4, 27, 32

Unit-I Topic	Question Numbers
Mathematical Induction	33
Resolution	15, 21, 34

IMPORTANT CORRECTIONS MADE FROM THE ORIGINAL QUESTION BANK

1. Questions that require **truth-table construction** have been changed from **L1 to L3**.
2. Questions requiring **proofs or logical analysis** have been changed to **L4**.
3. Questions asking students to **explain concepts** have been assigned **L2**.
4. Definitions and direct recall questions remain **L1**.
5. Unit-I questions are mapped primarily to **CO1**.
6. **PO1 and PO2** are used as the major PO mappings for Unit-I.
7. Several questions were rewritten for mathematical clarity and correct notation.
8. The statement involving “two propositions” was corrected to **“two propositions”** rather than “two proportions.”
9. The conditional statement involving the cloudy sky was simplified to a mathematically meaningful form.
10. The original question asking students to prove a tautology was retained but assigned **L4**, because proving and analyzing a logical equivalence is not merely remembering.
11. Mathematical induction has been included because it is explicitly mentioned in the **Course Objectives** and is an important method of proof. If induction is **not actually present in the official NR25 Unit-I syllabus**, Question 33 should be moved to the appropriate unit or removed.
12. The question bank now contains a better balance of **L1, L2, L3 and L4** questions rather than assigning L1 to most questions.

RECOMMENDED BLOOM'S TAXONOMY DISTRIBUTION

BT Level	Approximate Weight	Main Purpose
L1 – Remembering	25%	Definitions, laws, principles and terminology
L2 – Understanding	15%	Explanation and interpretation
L3 – Applying	35%	Truth tables, symbolic translation and normal forms
L4 – Analyzing	25%	Proofs, validity and logical analysis

Note: L5 and L6 can be introduced where the institution expects higher-order questions, particularly in assignments, tutorials, or advanced question banks.

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.