# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE-4 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK**

## Subject Name & Code:
## Discrete Mathematics (3140708)

## Unit 1: Set Theory, Functions, and Counting

**Repeated Questions:**

1. **Prove or verify set identities (e.g., $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$).**
   - Appeared in:
     - S25 (Q1a, 03 marks)
     - S24 (Q3b, 04 marks)
     - W25 (Q2c(i), 07 marks)
     - W22 (Q1b, 03 marks)
2. **Find $A \cup B$, $A \cap B$, $A - B$, etc., for given sets.**
   - Appeared in:
     - S23 (Q1a, 03 marks)
     - S24 (Q1a, 03 marks)
     - W24 (Q3b, 04 marks)
3. **Check whether a given function is injective, surjective, bijective, or invertible.**
   - Appeared in:
     - S24 (Q1c(i), 03 marks)
     - W24 (Q1a, 03 marks)
     - W23 (Q1a, 03 marks)
     - W22 (Q2b, 04 marks)
4. **Find composition of functions $f \circ g$ and $g \circ f$.**
   - Appeared in:
     - S25 (Q1c(II), 04 marks)
     - W23 (Q1c(i), 03 marks)
5. **Solve counting problems (permutations, combinations, pigeonhole principle).**
   - Appeared in:
     - S24 (Q3b(i-iv), 04 marks)
     - W24 (Q1c(i), 04 marks)
     - S23 (Q2c(II), 04 marks)
     - W22 (Q1a, 03 marks)

**Other Important Questions:**

1. **Define and explain: Functionally complete set, PDNF, characteristics function.**
   - Appeared in: W22 (Q1c, 07 marks)
2. **Find bitwise OR, XOR of bit strings.**
   - Appeared in: W22 (Q1c(1), 03 marks)
3. **Prove: $f_{A \cap B}(x) = f_A(x) \cdot f_B(x)$ for characteristic functions.**
   - Appeared in: W22 (Q1c(3), 03 marks)
4. **Number of integers divisible by given numbers in a range.**
   - Appeared in: W25 (Q2c, 07 marks)
5. **Venn diagram problems (students studying languages, etc.).**
   - Appeared in:
     - S23 (Q2a, 03 marks)
     - W24 (Q3b, 04 marks)
6. **Find number of ways to form committees with conditions.**
   - Appeared in:
     - S23 (Q3a, 03 marks)

- W22 (Q1a, 03 marks)

---

# Unit 2: Propositional and Predicate Logic

**Repeated Questions:**

1. **Check whether a given proposition is a tautology, contradiction, or contingency.**
   - Appeared in:
     - S25 (Q3b, 04 marks)
     - S24 (Q2a, 03 marks)
     - W25 (Q3a, 03 marks)
     - W23 (Q2a, 03 marks)
2. **Prove logical equivalence (e.g., $p \rightarrow q \equiv \neg p \vee q$).**
   - Appeared in:
     - S23 (Q1c(I), 03 marks)
     - W25 (Q3(a), 03 marks)
3. **Use truth tables to verify laws or argument validity.**
   - Appeared in:
     - S24 (Q2c, 04 marks)
     - W24 (Q2c, 04 marks)
     - W23 (Q2c, 04 marks)
4. **Symbolize expressions using predicates and quantifiers.**
   - Appeared in:
     - S24 (Q2c(i-ii), 04 marks)
     - W24 (Q2c(i), 04 marks)
     - W23 (Q2c(i-ii), 04 marks)
5. **Check validity of arguments using quantifiers.**
   - Appeared in: W22 (Q2b, 04 marks)

**Other Important Questions:**

1. **Define: Free and bound variables, validity of formulas.**
   - Appeared in: W22 (Q2c, 04 marks)
2. **Write propositions using disjunctions/conjunctions for given quantifiers.**
   - Appeared in: W22 (Q2c(1), 04 marks)
3. **Show logical (non-)equivalence of quantified statements.**
   - Appeared in: W22 (Q2c(2), 04 marks)
4. **Negate quantified statements.**
   - Appeared in: W25 (Q3b, 04 marks)

---

# Unit 3: Relations, Partial Ordering, and Lattices

**Repeated Questions:**

1. **Check whether a relation is reflexive, symmetric, transitive, antisymmetric.**
   - Appeared in:
     - S25 (Q1b, 04 marks)
     - S24 (Q1b, 04 marks)
     - S23 (Q1b, 04 marks)
     - W24 (Q1b, 04 marks)
     - W23 (Q1b, 04 marks)
2. **Prove that a given relation is an equivalence relation.**
   - Appeared in:
     - S25 (Q2b, 04 marks)
     - W23 (Q4a, 03 marks)
3. **Draw Hasse diagram for a given poset.**
   - Appeared in:
     - S25 (Q3a, 03 marks)
     - S24 (Q4b, 04 marks)
     - S23 (Q4c, 04 marks)
     - W25 (Q3c, 07 marks)
4. **Find maximal/minimal/greatest/least elements, GLB, LUB.**
   - Appeared in:
     - S25 (Q4c(ii-iii), 04 marks)
     - S24 (Q4a(i-iii), 03 marks)
     - W24 (Q4b(i-iv), 04 marks)
5. **Solve recurrence relations (homogeneous/non-homogeneous).**
   - Appeared in:
     - S25 (Q2c, 07 marks)
     - W25 (Q3c, 07 marks)
     - W24 (Q4c, 07 marks)
     - W22 (Q2c, 07 marks)

**Other Important Questions:**

1. **Find relation matrix, digraph, composition of relations.**
   - Appeared in:
     - S23 (Q2c(I-III), 07 marks)
     - W24 (Q4c, 07 marks)
2. **Find transitive closure using Warshall's algorithm.**
   - Appeared in:
     - S25 (Q5c, 07 marks)
     - S23 (Q5b, 04 marks)
     - W23 (Q4b, 04 marks)
3. **Define and check: Partition, equivalence classes, compatibility blocks.**
   - Appeared in:
     - S24 (Q4a, 03 marks)
     - W23 (Q4a, 04 marks)
4. **Prove lattice properties (distributive, modular, etc.).**
   - Appeared in:
     - S25 (Q4c(i-iii), 07 marks)
     - S24 (Q4c(i-ii), 07 marks)
5. **Solve recurrence using generating functions.**
   - Appeared in:
     - S23 (Q3c, 07 marks)
     - W24 (Q4c, 07 marks)
     - W22 (Q2c, 07 marks)

# Unit 4: Algebraic Structures (Groups, Rings, Fields)

**Repeated Questions:**

1. **Prove that a given set is a group/abelian group.**
   - Appeared in:
     - S25 (Q5a, 03 marks)
     - S24 (Q2b, 04 marks)
     - W25 (Q5b, 04 marks)
     - W22 (Q4a, 03 marks)
2. **Show that a subset is a subgroup/normal subgroup.**
   - Appeared in:
     - S25 (Q4c, 07 marks)
     - S24 (Q3a, 03 marks)
     - W24 (Q3c(i), 03 marks)
3. **Find cosets (left/right) of a subgroup.**
   - Appeared in:
     - S24 (Q3a, 03 marks)
     - W24 (Q3c(ii), 04 marks)
4. **Prove that a structure is an integral domain/field.**
   - Appeared in:
     - S25 (Q3c, 07 marks)
     - S24 (Q3c, 07 marks)
     - W25 (Q5c, 07 marks)
     - S23 (Q5c, 07 marks)
5. **Show properties in a lattice ($a \oplus b = b * c$, etc.).**
   - Appeared in:
     - S25 (Q5b, 04 marks)
     - S23 (Q3b, 04 marks)

**Other Important Questions:**

1. **Define: Semigroup, monoid, cyclic group, homomorphism.**
   - Appeared in:
     - S24 (Q3c(i-ii), 07 marks)
     - W25 (Q5b, 04 marks)
     - W22 (Q3a, 03 marks)
2. **Find generators of a cyclic group.**
   - Appeared in: W24 (Q3a, 03 marks)
3. **Prove Lagrange's theorem and find subgroups.**
   - Appeared in: W22 (Q5a, 03 marks)
4. **Show that every element being its own inverse implies abelian.**
   - Appeared in: W24 (Q2a, 03 marks)
5. **Find units, inverses, roots in $\mathbb{Z}_n$.**
   - Appeared in:
     - W24 (Q3c, 07 marks)
     - W23 (Q3c, 07 marks)
6. **Define and find: Principal ideals in a ring.**
   - Appeared in: W22 (Q4c, 07 marks)

---

# Unit 5: Graphs and Trees

**Repeated Questions:**

1. **Define: Connected graph, Euler path, tree, regular graph, bipartite graph.**
   - Appeared in:
     - S25 (Q1c(I), 03 marks)
     - S25 (Q3a, 03 marks)
     - W25 (Q4b, 04 marks)
     - W22 (Q5b, 04 marks)
2. **Check whether two graphs are isomorphic.**
   - Appeared in:
     - S25 (Q5c, 07 marks)
     - W24 (Q5b, 04 marks)
     - W23 (Q1c(ii), 03 marks)
3. **Find number of vertices/edges given degree conditions.**
   - Appeared in:
     - S25 (Q3c(I), 03 marks)
     - S24 (Q5a, 03 marks)
     - S23 (Q4b, 07 marks)
4. **Draw specific graphs (complete, bipartite, regular, tree).**
   - Appeared in:
     - W25 (Q1a, 03 marks)
     - W25 (Q4b(i-iv), 04 marks)
     - S24 (Q5b(I-II), 04 marks)
5. **Traversal of trees (pre-order, in-order, post-order).**
   - Appeared in:
     - W24 (Q5c, 07 marks)
     - W22 (Q5c, 07 marks)

**Other Important Questions:**

1. **Find reachable set, node base, distance in digraphs.**
   - Appeared in:
     - S23 (Q3a, 03 marks)
     - W24 (Q5b, 04 marks)
     - W23 (Q5b, 04 marks)
2. **Find adjacency/path matrix, use Warshall's algorithm.**
   - Appeared in:
     - S24 (Q5c, 07 marks)
     - W23 (Q5b, 04 marks)
3. **Find minimal spanning tree (weighted graph).**
   - Appeared in:
     - W25 (Q4c, 07 marks)
     - W22 (Q5c, 07 marks)
4. **Define: Strong/unilateral/weak components in digraphs.**
   - Appeared in: W23 (Q5c, 07 marks)
5. **Prove: Tree with $n$ vertices has $n - 1$ edges.**
   - Appeared in: S24 (Q1c(ii), 03 marks)
6. **Construct binary search tree from given data.**
   - Appeared in: W22 (Q5b, 04 marks)

**********