



Module 1

Chapter 1 : Logic**1-1 to 1-46**

<ul style="list-style-type: none"> 1.1 Theory of Predicate Calculus..... 1-1 1.2 Propositions 1-1 <ul style="list-style-type: none"> 1.2.1 Definition 1-1 1.2.2 Notation..... 1-2 1.3 Logical Operations 1-2 <ul style="list-style-type: none"> 1.3.1 Negation..... 1-2 1.3.2 Conjunction (And)..... 1-2 <ul style="list-style-type: none"> 1.3.2(A) Examples on Conjunction (And) 1-2 1.3.3 Disjunction (or) 1-3 <ul style="list-style-type: none"> 1.3.3(A) Examples on Disjunction (or)..... 1-3 1.3.4 Conditional (if ...then)..... 1-3 <ul style="list-style-type: none"> 1.3.4(A) Solved Examples on Logical Operations 1-3 1.3.5 Biconditional (if and only if)..... 1-4 1.4 Propositional or Statement Form 1-4 <ul style="list-style-type: none"> 1.4.1 Solved Examples on Propositional or Statement Form 1-5 1.5 Truth Tables 1-9 <ul style="list-style-type: none"> 1.5.1 Solved Examples on Truth Tables 1-10 1.6 Tautology and Contradiction..... 1-13 <ul style="list-style-type: none"> 1.6.1 Definitions 1-13 1.6.2 Exmaples on Tautology and Contradiction 1-14 1.7 Logical Implication..... 1-16 <ul style="list-style-type: none"> 1.7.1 Solved Examples on Logical Implication..... 1-16 	<ul style="list-style-type: none"> 1.8 Laws of Logic 1-16 <ul style="list-style-type: none"> 1.8.1 Laws..... 1-16 1.8.2 Solved Examples on Laws of Logic 1-17 1.9 Equivalence of Statement Forms 1-20 <ul style="list-style-type: none"> 1.9.1 Definition 1-20 1.9.2 Solved Examples on Equivalence of Statement Forms..... 1-20 <ul style="list-style-type: none"> 1.9.3 Theorem..... 1-24 1.10 Quantifier..... 1-25 <ul style="list-style-type: none"> 1.10.1 Predicates 1-25 <ul style="list-style-type: none"> 1.10.2 Types of Quantifiers 1-25 <ul style="list-style-type: none"> 1.10.2(A) Universal Quantifier 1-25 1.10.2(B) Existential Quantifier 1-26 1.10.2(C) Examples on Quantifiers 1-26 1.10.3 Negation of a Quantified Statement..... 1-26 <ul style="list-style-type: none"> 1.10.3(A) Solved Examples on Quantifier 1-26 1.11 Normal Forms 1-29 <ul style="list-style-type: none"> 1.11.1 Disjunctive Normal Form 1-30 <ul style="list-style-type: none"> 1.11.1(A) Solved Examples on Normal Forms 1-30 1.11.2 Conjunctive Normal Form(CNF) 1-31 <ul style="list-style-type: none"> 1.11.2(A) Solved Examples on Conjunctive Normal Form(CNF) 1-31 1.12 Mathematical Induction 1-32 <ul style="list-style-type: none"> 1.12.1 Principle of Mathematical Induction 1-32 1.12.2 Solved Examples on Mathematical Induction 1-33
--	--



Module 2

Chapter 2 : Relations and Functions 2-1 to 2-80

<p>2.1 Sets.....2-1</p> <p>2.1.1 Notation.....2-1</p> <p>2.1.2 Some Special Sets (Number Sets).....2-2</p> <p>2.1.3 Definitions2-2</p> <p>2.1.3(A) Subset.....2-2</p> <p>2.1.3(B) Equal Sets.....2-2</p> <p>2.1.3(C) Proper Subset2-2</p> <p>2.1.3(D) Universal Set.....2-2</p> <p>2.1.3(E) Null Set or Empty Set.....2-3</p> <p>2.1.3(F) Singleton Set.....2-3</p> <p>2.1.3(G) Super Set2-3</p> <p>2.1.3(H) Finite Set.....2-3</p> <p>2.1.3(I) Infinite Set2-3</p> <p>2.1.3(J) Disjoint Sets2-3</p> <p>2.1.3(K) Cardinality of Finite Set2-3</p> <p>2.1.4 Solved Examples on Set Theory.....2-3</p> <p>2.1.5 Set Properties2-4</p> <p>2.1.6 Partitions of Sets2-4</p> <p>2.1.6(A) Solved Examples on Partitions of Sets.....2-4</p> <p>2.2 Power Set.....2-6</p> <p>2.2.1 Solved Examples on Power Set.....2-6</p> <p>2.3 Relations2-7</p>	<p>2.3.1 Definition2-8</p> <p>2.3.2 Set Arising from Relations2-9</p> <p>2.3.2(A) Definition2-9</p> <p>2.3.2(B) Theorem2-9</p> <p>2.3.3 Representation of Relation2-10</p> <p>2.3.3(A) Examples on Representation of Relation.....2-10</p> <p>2.3.4 Digraphs.....2-11</p> <p>2.3.4(A) Definition2-11</p> <p>2.3.4(B) Examples on Digraphs2-11</p> <p>2.3.5 Paths in Relations and Digraphs2-16</p> <p>2.3.5(A) Definitions2-16</p> <p>2.3.5(B) Examples on Paths in Relations and Digraphs2-17</p> <p>2.4 Types of Relations.....2-22</p> <p>2.4.1 Reflexive Relations.....2-22</p> <p>2.4.2 Irreflexive Relations2-22</p> <p>2.4.3 Symmetric Relations2-22</p> <p>2.4.3(A) Digraph of Symmetric Relation.....2-23</p> <p>2.4.4 Connected Relation2-23</p> <p>2.4.5 Asymmetric Relations.....2-23</p> <p>2.4.6 Antisymmetric Relations.....2-24</p> <p>2.4.7 Transitive Relations2-24</p> <p>2.4.7(A) Theorem.....2-25</p> <p>2.4.8 Identity Relation.....2-25</p> <p>2.4.9 Void Relation.....2-25</p> <p>2.4.10 Universal Relation2-25</p>
---	---



2.4.11	Examples	2-25	2.13	Inverse Function.....	2-77
2.5	Equivalence Relations	2-29	2.13.1	Definition	2-77
2.5.1	Definition	2-29	2.13.2	Theorem.....	2-78
2.5.2	Equivalence Relations and Partitions	2-30	2.13.3	Examples on Inverse Function	2-79
2.5.3	Refinement of Partition.....	2-30	Module 3		
2.5.4	Equivalence Classes	2-30	<hr/>		
2.5.5	Examples on Equivalence Relation	2-31	Chapter 3 : Posets and Lattice 3-1 to 3-53		
2.6	Closure.....	2-44	3.1	Partially Ordered Relation and Poset.....	3-1
2.6.1	Definitions	2-44	3.1.1	Definitions	3-1
2.6.2	Solved Examples on Closure.....	2-45	3.1.2	Examples	3-1
2.7	Warshalls Algorithm	2-48	3.1.3	Dual of Poset.....	3-1
2.8	Smallest Equivalence Relation	2-50	3.1.4	Product Partial Order.....	3-2
2.8.1	Examples on Smallest Equivalence Relation.....	2-50	3.1.5	Solved Examples on Poset.....	3-2
2.9	Functions.....	2-63	3.2	Hasse Diagram	3-2
2.9.1	Definition	2-63	3.2.1	Procedure.....	3-2
2.9.2	Examples on Functions	2-63	3.2.2	Solved Examples on Hasse Diagram	3-2
2.10	Types of Functions	2-64	3.3	Chain and Antichain	3-12
2.10.1	Onto or Surjective Function	2-64	3.3.1	Definition	3-12
2.10.2	One to One or Injective Function	2-64	3.3.2	Examples on Chain and Antichain.....	3-12
2.10.3	One to One onto Function or Bijective Function	2-65	3.3.3	Maximal Element, Minimal Element.....	3-20
2.10.4	Everywhere Defined Function.....	2-65	3.3.4	Greatest Element, Least Element	3-21
2.10.5	Examples on Functions	2-65	3.3.5	Upper Bound, Lower Bound	3-22
2.11	Composition	2-69	3.3.5(A)	Examples on Upper Bound, Lower Bound	3-22
2.11.1	Definition	2-69	3.4	Lattices.....	3-24
2.11.2	Solved Examples on Composition	2-70	3.4.1	Definition	3-24
2.12	Identity	2-77	3.4.1(a)	Examples on Lattices	3-24



3.4.2	Sublattice	3-27
3.4.2(A)	Examples on Sublattice	3-27
3.4.3	Properties of Lattices.....	3-28
3.4.4	Dual of a Lattice	3-28
3.4.4(A)	Examples on Dual of a Lattice	3-29
3.5	Isomorphic Lattices :	3-30
3.5.1	Examples on Isomorphic Lattices	30
3.6	Types of Lattices	3-31
3.6.1	Bounded Lattice	3-31
3.6.2	Distributive Lattice	3-31
3.6.2(A)	Examples on Distributive Lattice	3-31
3.6.3	Complemented Lattice	3-32
3.6.3(A)	Examples on Complemented Lattice	3-32
3.6.4	Boolean Algebra.....	3-34
3.6.4(A)	Examples on Boolean Algebra	3-34

Module 4

Chapter 4 : Counting **4-1 to 4-33**

4.1	Basic Counting Principles.....	4-1
4.1.1	Sum Rule Principle.....	4-1
4.1.2	Product Rule Principle	4-1
4.1.3	Subtraction Principle	4-1
4.1.4	Bijection Principle	4-1
4.1.5	Principle of Inclusion – Exclusion	4-1
4.1.6	Mutual Inclusion – Exclusion Principle for Three Sets .	4-2
4.1.7	Solved Examples on Basic Counting Principles.....	4-2

4.2	The Pigeonhole Principle	4-20
4.2.1	Theorem of Pigeonhole Principle	4-20
4.2.2	The Extended Pigeonhole Principle.....	4-20
4.2.3	Solved Examples on Pigenhole Principle.....	4-21
4.3	Recurrence Relations	4-26
4.3.1	Linear Recurrence Relations with Constant Coefficients	4-26
4.3.2	Homogeneous Solutions	4-26
4.3.3	Case of Distinct Roots.....	4-27
4.3.4	Case of Equal Roots	4-27
4.3.5	Case of Complex Roots.....	4-27
4.3.6	Solved Examples on Recurrence Relation.....	4-27

Module 5

Chapter 5 : Algebraic Structures **5-1 to 5-53**

5.1	Binary Operations Revisited	5-1
5.1.1	Examples	5-1
5.1.2	Tables	5-2
5.1.3	Algebraic System	5-2
5.1.4	Properties of Binary Operations.....	5-2
5.1.5	Solved Examples Binary Operations	5-3
5.2	Semigroups, Monoids and Groups	5-3
5.2.1	Semigroups.....	5-3
5.2.1(A)	Definition	5-3
5.2.1(B)	Examples	5-3
5.2.1(C)	Sub-semigroup.....	5-3
5.2.2	Monoid	5-4



5.2.2(A) Identity	5-4	5.3 Rings.....	5-25
5.2.2(B) Definition	5-4	5.3.1 Definition	5-25
5.2.2(C) Examples	5-4	5.3.2 Special Types of Ring	5-26
5.2.2(D) Submonoid	5-4	5.3.3 Cancellation Laws in a Ring	5-26
5.2.3 Group	5-4	5.3.4 Basic Properties	5-26
5.2.3(A) Inverse	5-4	5.3.5 Subring.....	5-27
5.2.3(B) Definition	5-5	5.3.6 Solved Examples on Ring	5-27
5.2.3(C) Commutative/Abelian Group.....	5-5	5.4 Coding Theory.....	5-36
5.2.3(D) Finite and Infinite Group	5-5	5.4.1 Weight.....	5-37
5.2.4 Examples on Semigroups, Monoids and Groups	5-5	5.4.2 Parity Check Code	5-37
5.2.5 Additive Modulo m	5-13	5.4.3 Hamming Distance	5-38
5.2.6 Examples on Additive Modulo m	5-13	5.4.3(A) Definition	5-38
5.2.7 Multiplication Modulo 'P'	5-14	5.4.4 Minimum Distance.....	5-38
5.2.8 Examples on Multiplication Modulo 'P'.....	5-14	5.4.4(A) Solved Examples on Minimum Distance.....	5-39
5.2.9 Cyclic Group.....	5-16	5.4.5 Group Codes	5-40
5.2.10 Subgroups.....	5-16	5.4.5(A) Definition	5-40
5.2.10(A) Proper Subgroup	5-17	5.4.5(B) Solved Examples on Group Codes.....	5-40
5.2.10(B) Generation of Subgroup	5-17	5.4.6 Mod 2 Boolean Product.....	5-44
5.2.10(C) Solved Examples on Subgroup.....	5-17	5.4.7 Parity Check Matrix	5-44
5.2.10(D) Coset.....	5-18	5.4.7(A) Solved Examples on Parity Check Matrix	5-45
5.2.10(E) Normal Subgroup	5-18	5.4.8 Maximum Likelihood Decoding Technique	5-48
5.2.10(F) Solved Examples on Normal Subgroup	5-18	5.4.8(A) Solved Examples on Maximum Likelihood Decoding Technique	5-49
5.2.11 Product Group.....	5-19		
5.2.12 Quotient Group.....	5-19		
5.2.13 Solved Examples on Product Group.....	5-19		
5.2.14 Isomorphism.....	5-23		
5.2.14(A) Solved Examples on Isomorphism	5-23		
		Module 6	
		Chapter 6 : Graph Theory	6-1 to 6-45
		6.1 Definitions	6-1
		6.1.1 Graph	6-1



6.1.2	Degree	6-1	6.2	Handshaking Lemma	6-7
6.1.3	Loop	6-1	6.2.1	Theorem.....	6-7
6.1.4	Isolated Vertex	6-2	6.2.2	Solved Examples on Handshaking Lemma	6-7
6.1.5	Adjacent Vertices	6-2	6.3	Euler Paths and Circuits.....	6-9
6.1.6	Path.....	6-2	6.3.1	Definition	6-9
6.1.7	Circuit.....	6-2	6.3.2	Theorems	6-9
6.1.8	Connected Graph	6-2	6.3.3	Solved Examples on Euler Paths and Circuits.....	6-10
6.1.8(A)	Solved Examples on Connected Graph	6-2	6.4	Hamiltonian Paths and Circuits	6-15
6.1.9	Discrete Graph	6-3	6.4.1	Definition	6-15
6.1.10	Complete Graph.....	6-3	6.4.1(A)	Solved Examples on Hamiltonian Paths and Circuits	6-15
6.1.11	Linear Graph	6-3	6.4.2	Theorems	6-16
6.1.12	Subgraph.....	6-3	6.4.3	Travelling Salesman Problem.....	6-21
6.1.12(A)	Spanning Subgraph	6-4	6.4.3(A)	Nearest – Neighbour Method.....	6-22
6.1.12(B)	Complement of Subgraph.....	6-4	6.4.4	Solved Examples on Travelling Salesman Problem..	6-22
6.1.12(C)	Subgraph Isomorphism	6-4	6.5	Isomorphic Graph.....	6-28
6.1.13	Directed Graph	6-4	6.5.1	Definition	6-28
6.1.13(A)	Incidence.....	6-5	6.5.2	Homomorphic Graph	6-29
6.1.13(B)	Indegree and Outdegree.....	6-5	6.5.3	Solved Examples on Isomorphic Graph.....	6-30
6.1.14	Simple Graph	6-5	6.6	Planar Graphs	6-40
6.1.15	Multigraph	6-5	6.6.1	Definition	6-40
6.1.16	Labelled and Weighted Graph.....	6-5	6.6.2	Theorem.....	6-40
6.1.17	Cut Set and Cut Vertex of Graph.....	6-5	6.6.3	Solved Examples on Planar Graphs	6-41
6.1.17(A)	Cut Set of a Graph	6-5	6.7	Applications of Graph Coloring in Computer Science:.....	6-45
6.1.17(B)	Cut Vertex	6-6			
6.1.17(C)	Cut Edge (Bridge).....	6-6			

• **Appendix** : Solved University Question Papers of
May 2019 and Dec. 2019..... A-1 to A-3

