

- Basic counting principles
 - Product rule, sum rule, division rule
- Permutations and combinations
 - combinatorial proofs
- Binomial theorem, Pascal's identity
- Generalized permutations and combinations
 - permutations and combinations with repetition
 - permutations of indistinguishable objects
 - Distributing objects into distinguishable boxes

- Solving linear recurrence relation
 - Theorem 4: the general homogeneous case: degree k , roots with multiplicity
 - Theorem 5: the general form of solutions for the nonhomogenous case
 - Theorem 6: a particular form of solutions for the nonhomogenous case
- Divide-and-conquer algorithms
 - Master theorem: $f(n) = af(n/b) + cn^d$,
- Inclusion and exclusion: two forms

- Relations and their properties
 - reflexive, symmetric, and transitive relations
 - composition of relations
- Closure of relations
 - reflexive, symmetric and transitive closures
- Equivalence relations
 - equivalence classes
- Partial orderings
 - Hasse diagrams
 - maximal and minimal elements, upper and lower bounds

- Basics of graphs
 - Handshaking theorem
 - Complete graphs, cycles, wheels, bipartite graphs
 - Adjacency matrices, incidence matrices
- Connectivity
 - Paths, connected component
 - Euler and Hamilton graphs
- Shortest path problem
 - Dijkstra's algorithm
- Planar graphs
 - Euler's formula: $r = e - v + 2$
 - $\deg(R) \geq 3, \sum \deg(R) = 2e$

- Properties of trees
 - $e = v - 1$
 - A full m -ary tree with i internal vertices contains $n = mi + 1$ vertices.
 - There are at most m^h leaves in an m -ary tree of height h .
- Tree traversal
 - Preorder, inorder, postorder traversal
 - Prefix, infix, postfix notation of expressions
- Application of trees
 - Decision trees
 - Prefix codes and Huffman coding
- Spanning trees
 - Prim's and Kruskal's algorithm