Q.1  a. Why do we use asymptotic notations in the study of algorithms? Briefly describe the commonly used asymptotic notations.
   b. Show that Quick Sort algorithm takes $O(n^2)$ time in the worst case.
   c. Explain any two methods to resolve collision during Hashing.
   d. Draw BSTs of height 2, 3 and 4 on the set of keys { 10,4,5,16,1,17,21}
   e. Give a simple way to implement Disjoint-set data structure.
   f. Show that the worst case complexity for simple text search (Naive string matching) to find the first occurrence of a pattern of length $m$ on a text of length $n$ is $\theta(n-m+1)(m-1)$.
   g. Define Red-Black Tree with an example.  

Q.2  a. Write an algorithm to merge two sorted lists using an auxiliary storage.
   b. Write down Rabin Karp string matching algorithm. Working modulo $q=11$, how many spurious hits does the Rabin Karp String matcher encounter in the text $T=3141592653589793$ when looking for the pattern $P=26$?

Q.3  a. Bob loves foreign languages and wants to plan his course schedule to take the following nine language courses:


The course prerequisites are:


Using Graphs, find a sequence of courses that allows Bob to satisfy all the prerequisites.
b. Draw a graph with 6 vertices that has unique ordering of vertices when topologically sorted. (2)

c. Let G be an undirected connected graph. Give an efficient algorithm to compute the second best minimum spanning tree of G. (8)

Q.4  

a. Write down Counting Sort algorithm. Illustrate the operation of counting sort on the following array:
A = {7, 1, 3, 1, 2, 4, 5, 7, 2, 4, 3} (7)

b. Describe an algorithm that, given n integers in the range 1 to k, preprocesses its input and then answers any query about how many of the n integers fall in the range [a..b] in O(1) time. Ignore the preprocessing time. (4)

c. Write an algorithm to find the Kth smallest element from a set of n different numbers without sorting it. (7)

Q.5  

a. Show the results of inserting the keys F, S, Q, K, C, L, H, T, V, W, M, R, N, P, A, B, X, Y, D, Z, E, I in order into an empty B tree of minimum degree 3. Only draw the configurations of the tree just before some node must split, and also draw the final configuration. (10)

b. What is backtracking? Find a solution to the 4-Queens problem using backtracking strategy. Draw the solution space using necessary bounding function. (8)

Q.6  

a. Deduce a recursive definition for finding the minimum cost of Matrix-Chain multiplication problem. Find an optimal parenthesisation of a matrix chain product whose sequence of dimension is: <5*10, 10*3, 3*12, 12*5, 5*50, 50*6> (9)

b. Write down the Floyd Warshall algorithm to solve the all pairs shortest paths problem on a directed graph. Run your algorithm on the following weighted directed graph and show the matrix Dk that results for each iteration of the outer loop. (9)
Q.7 Write short notes on any **THREE**

(i) Prefix Function in KMP algorithm
(ii) Hash Functions
(iii) Depth First Search
(iv) The Complexity Class NP