(vii) An algorithm is made up of 2 modules M1 & M2. If order of M1 is f(n), M2 is g(n), then the order of the algorithm is
(a) max(f(n), g(n)) (b) min(f(n), g(n))
(c) f(n) + g(n) (d) f(n) * g(n)

(viii) In the KMP algorithm for pattern matching, the suffix function σ(x) is the _____est _____ of the pattern P that is also a _____ of x.
(a) large, prefix, suffix (b) small, prefix, suffix
(c) large, suffix, prefix (d) small, suffix, prefix.

(ix) The recurrence relation representing the time complexity of the Tower-of-Hanoi problem in worst case with n discs is
(a) T(n) = 2T(n – 2) + 2 (b) T(n) = 2T(n – 1) + n
(c) T(n) = 2T(n/2) + 1 (d) T(n) = 2T(n – 1) + 1.

(x) Consider the following code snippet
```
for i = 1 to n do
begin
 sum = sum + A[i];
  if i == 100 then break;
end
```
The time complexity of the above code snippet in worst case is
(a) $O(n^2)$ (b) O(n) (c) O(100) (d) None of these

Group – B

2. (a) What do you mean by running time of an algorithm? How do you judge the efficiency of an algorithm?
(b) Define Big-oh (O), Big-omega (Ω) and Big-theta (θ) notations.
(c) Let's assume that a polynomial of degree m is represented as

$t(n)=\sum_{i=0}^{m} a_i n^i$. Prove that $t(n)=O(n^m)$

(2 + 2) +3 + 5 = 12

3. (a) What is the significance of doing amortized analysis of an algorithm? Explain it with suitable example.
(b) A sequence of n operations is performed on a data structure. The i^{th} operation costs i if i is an exact power of 2 and 1 otherwise. Assuming that we start with an empty set, determine the amortized cost per operation using both aggregate method and accounting method.

2 + (5 + 5) = 12

Group – C

4.(a) You are given a sorted array of n distinct integers. Write an algorithm to search an element from the given set of elements using Binary search.
(b) When do the best-case and worst cases happen in your Binary search algorithm and just state what is the number of comparisons required in each case? Analyze the worst case performance of your algorithm.

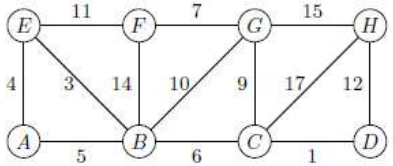
5 + (3 + 4) = 12

5. (a) Write down the basic principles of any Divide-and-Conquer method.
(b) Formulate Merge Sort algorithm as a Divide-and-Conquer approach. Analyze the performance of this algorithm in worst case.

3+ (5 + 4) = 12

Group – D

6 (a) Define a spanning tree.
Consider the weighted graph below. Apply Priority Queue based Prim's algorithm on this graph starting from vertex A. Write the edges in which order they are added to the minimum spanning tree (MST).



(b) Give the pseudo-code for Kruskal's algorithm for MST with a very brief explanation of how it works. Note that you do NOT need to write the implementation details of disjoint-set data structure.

(2 + 5) + 5 = 12

7. (a) (i) Prove that sub-paths of shortest paths are also shortest paths.
(ii) What is the asymptotic time complexity of Bellman Ford Algorithm? Justify your answer.
(b) Give the pseudo code for doing DFS on a directed graph, represented as an adjacency list. What are the different types of edges you will identify while doing the traversal?

(2 + 2)+(5 + 3) = 12

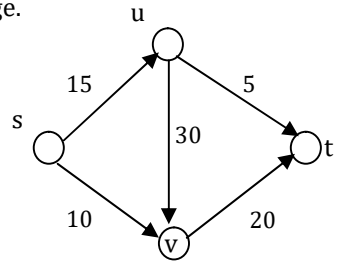
Group – E

8. (a) Suppose that the procedure 'Compute-Prefix-Function (P)' is available to you. Write the pseudo-code for KMP matcher (T, P) for text T and pattern P using the above procedure.

(b) Show how KMP algorithm works to solve the string matching problem for the following case:
String S: bacbababababacaca
Pattern P: ababaca

5 + 7 = 12

9. (a) Apply FORD-FULKERSON algorithm on the following flow network to find the maximum flow in the network. s & t denote source & destination respectively and the weights associated with every edge represents capacity of the respective edge.



(b) Define P, NP, NP-Hard problems. What are two things you have to show, to prove that a problem is NP-complete?

7 + (3+2) = 12

M.TECH/CSE/1ST SEM/CSEN 5102 (BACKLOG)/2018
ALGORITHMS & COMPLEXITY
(CSEN 5102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Lower bound for any comparison based sort in worst case is
(a) O(log n) (b) $O(n^2)$ (c) O(n logn) (d) O(n).

(ii) Time complexity for the Floyd's algorithm to find all pairs of shortest path of a graph G with V vertices & E edges using dynamic programming method is
(a) $O(V^2)$ (b) $O(E^2)$ (c) $O(V^3)$ (d)$O(E^3)$.

(iii) The Single-source shortest path problem in a graph G becomes undefined if there exists _____from the source.
(a) a –ve weight cycle in the graph
(b) a –ve edge reachable from the source
(c) multiple –ve edges in the graph
(d) a –ve weight cycle reachable from the source.

(iv) A problem L is NP-complete iff L is NP-hard and
(a) L ≈ NP (b) L α NP (c) L ∈NP (d)L=NP

(v) Topological Sort cannot be done in a directed graph of n vertices if the graph contains
(a) more than n edges (b) contains a directed cycle
(c) contains a rooted tree (d) all of the above.

(vi) The augmenting path in a flow network
(a) determines the edge connectivity of a network
(b) comprises edges which can admit positive flow
(c) converts a tree network into a cyclic chain
(d) used only for cyclic chain networks.