



Reg. No. : .....

Name : .....

**First Semester M.Tech. Degree Examination, June 2017**  
**(2013 Scheme)**  
**Branch : COMPUTER SCIENCE ENGINEERING**  
**RCC 1003 : Advanced Data Structures and Algorithms**  
**(2014 Admn.)**

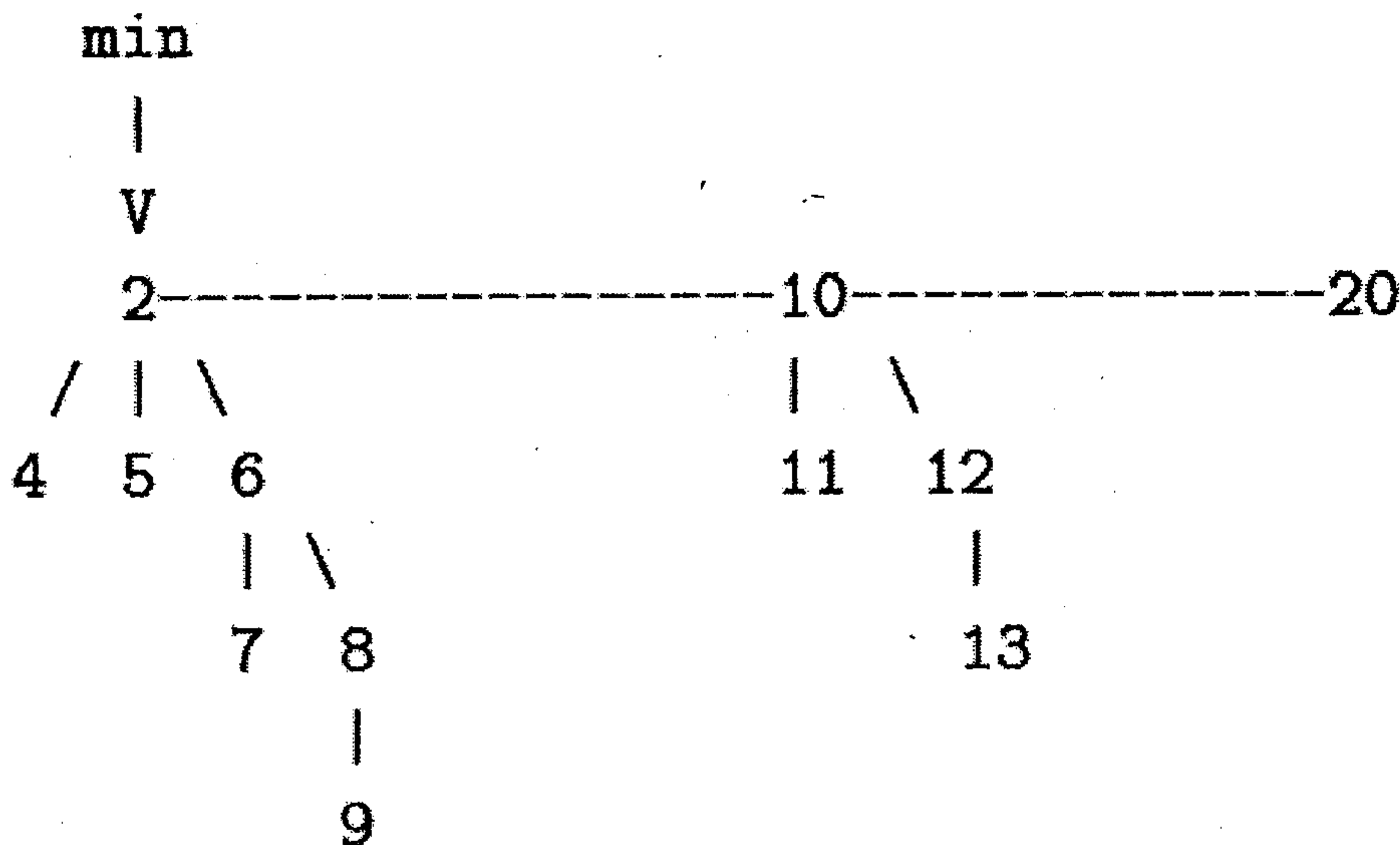
Time : 3 Hours

Max. Marks : 60

**Instruction : Answer any two full questions from each Module.**

MODULE - I

1. a) Consider an ordinary binary min-heap data structure with  $n$  elements that supports the instructions INSERT and EXTRACT-MIN in  $O(\lg n)$  worst-case time. Give a potential function  $\Phi$  such that the amortized cost of INSERT is  $O(\lg n)$  and the amortized cost of EXTRACT-MIN is  $O(1)$ , and show that it works. 5
- b) For the following min Fibonacci heap, assume that the ChildCut field of all nodes is TRUE.



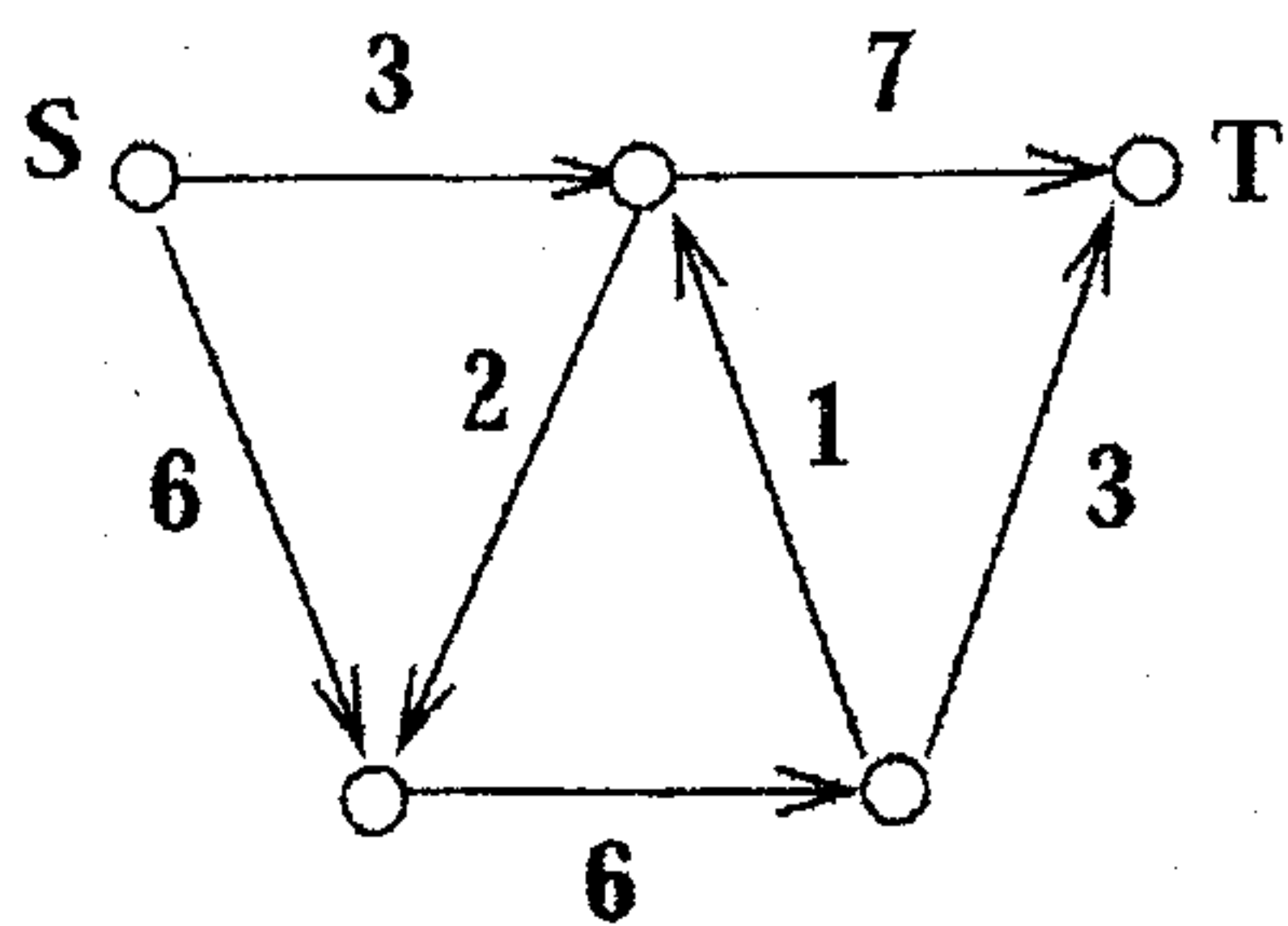
For the min Fibonacci heap of Figure given above, perform a DecreaseKey operation by changing 8 to 1. Draw the resulting min Fibonacci heap, clearly label ChildCut values.

5

P.T.O.



2. a) Prove that the maximum degree of any node in an  $n$ -node binomial tree is  $\lg n$ . 4
- b) List four properties of binomial trees. 2
- c) Explain an application of disjoint-set data structures. 4
3. a) What is the maximum value of S-T flow from the source S to sink T in the graph below ?



- b) Draw the residual graph that results after running the Ford-Fulkerson algorithm to completion on the above graph. Label the edges with their residual capacities. 5

#### MODULE – II

4. a) What is the difference between pseudo random numbers and quasi random numbers ? Give the first 10 numbers of the *van der Corput quasi random number* sequence with base 3. Write them in decimal rational form with the common denominator 9. 4
- b) Using Monte Carlo method, approximate the integral of  $f(x) = (2\pi)^{-1/2} e^{-x^2}$  for  $-1 \leq x \leq 1$ . Do you obtain the same result by choosing the interval  $[0, 1]$  and then multiplying by two ? Why or why not ? 6
5. a) Randomized quick sort is an extension of quick sort where the pivot is chosen randomly. What is the worst case complexity of sorting  $n$  numbers using randomized quick sort ? Justify your answer. 4
- b) Explain Jarvis March to find the Convex Hull of a Set of Points in 2D. 4
- c) Given an unsorted set of  $n$  elements which contains all but one of the integers in the range 0 to  $n$ . Suggest a suitable data structure and design an algorithm to determine the missing integer in  $O(n)$  time. 2



- 6. a) Given an array of  $n$  points in the plane. Write an algorithm to find out the closest pair of points in the array. 5
- b) List the two practical applications of the above algorithm. 1
- c) Given three corner points of a triangle, and one more point  $P$ . Write an algorithm in pseudo code to check whether  $P$  lies within the triangle or not. 4

MODULE – III

- 7. a) Given a text  $text[0..n - 1]$  and a pattern  $pat[0..m - 1]$ , write an algorithm search ( $char\ pat[ ], char\ text[ ]$ ) that prints all occurrences of  $pat[ ]$  in  $text[ ]$ . You may assume that  $n > m$ . Use Knuth-Morris-Prat algorithm. Discuss the complexity of the algorithm. 5
- b) A vertex cover of an undirected graph is a subset of its vertices such that for every edge  $(u, v)$  of the graph, either 'u' or 'v' is in vertex cover. Given an undirected graph, the vertex cover problem is to find minimum size vertex cover. Write an approximate algorithm for vertex cover. 4
- c) Which of the following problems is not in NP ?  
i) CLIQUE    ii) 3SAT    iii) Hamiltonian Path    iv) Halting Problem. 1
- 8. a) Write brief note on the following :  
i) Randomized complexity classes  
ii) Number theoretic algorithms. 6
- b) Compare the complexity of KMP algorithm with Rabin Karp algorithm. 2
- c) NP-complete problems are the hardest problems in NP set. Justify this statement. 2
- 9. a) How many steps would you expect POLLARD-RHO to require to discover a factor of the form  $p^e$ , where  $p$  is prime and  $e > 1$  ? Justify your answer. 4
- b) With an example, explain Rabin Karp algorithm. 4
- c) Why NP-complete problems are important in computer science domain ? 2

