
INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR
CS21003 Algorithms I: End Semester Examination 2022 Spring

Date of Examination: 12th April 2022

Duration: 55 minutes + 5 minutes (for scanning, concatenating, and uploading)

Full Marks: 20

Subject: CS21003 Algorithms I

Part 2

1. Given a **weighted acyclic directed graph** where the weights on the edges can be positive, negative or 0, Present an efficient algorithm that finds the **shortest cost path between nodes s and g that must go through node p** . If there are more than one such shortest cost paths, then select the one with minimum length, where length is the number of edges on the path. The algorithm must report the path as well as its cost. Take care to report the case where there is no such path. Show the working of your algorithm on an example of your own and analyse its complexity.

[10 Marks]

2. Present an **efficient heap-based data structure** to store positive integers with the following operations: **insert, remove-max, remove-second-max**. There may be **duplicate elements**. Note that we are looking for the **distinct second-max**. That is, if the elements inserted are {15, 4, 6, 6, 15, 1}, then the max is 15 and the second-max is 6. Also **removal removes only one instance of the element** of that value and not all instances. That is, if we apply remove-max operation in the above example, we will be left with {15, 4, 6, 6, 1}. Clearly show the heap pictorially as well as its mapping to the array to store the heap. Present algorithms for all the operations mentioned above as well as those needed to perform various update operations. Give your own examples. Analyse the time complexity of the operations and the space complexity of the data structure.

[10 Marks]

All the best!!!
