

National Institute of Technology Calicut
Department of Computer Science and Engineering
Fourth Semester B. Tech.(CSE)-Winter 2022-23
CS2094D Data Structures Laboratory
Assignment #3

Submission deadline (on or before):

Policies for Submission and Evaluation:

- You must submit your assignment in the Eduserver course page, on or before the submission deadline.
- Ensure that your programs will compile and execute without errors using gcc compiler.
- During the evaluation, failure to execute programs without compilation errors may lead to zero marks for that evaluation.
- Your submission will also be tested for plagiarism, by automated tools. In case your code fails to pass the test, you will be straightaway awarded zero marks for this assignment and considered by the examiner for awarding F grade in the course. Detection of ANY malpractice related to the lab course can lead to awarding an F grade in the course.

Naming Conventions for Submission

- Submit a single ZIP (.zip) file (do not submit in any other archived formats like .rar, .tar, .gz). The name of this file must be

ASSG<NUMBER>_<ROLLNO>_<BATCHNO>_<FIRST-NAME>.zip

(Example: *ASSG3_BxyyyyCS_CS01_LAXMAN.zip*). DO NOT add any other files (like temporary files, input files, etc.) except your source code, into the zip archive.

- The source codes must be named as

ASSG<NUMBER>_<ROLLNO>_<BATCHNO>_<FIRST-NAME>_<PROGRAM-NUMBER>.c

(For example: *ASSG3_BxyyyyCS_CS01_LAXMAN_1.c*). If you do not conform to the above naming conventions, your submission might not be recognized by our automated tools, and hence will lead to a score of 0 marks for the submission. So, make sure that you follow the naming conventions.

Standard of Conduct

- Violation of academic integrity will be severely penalized. Each student is expected to adhere to high standards of ethical conduct, especially those related to cheating and plagiarism. Any submitted work MUST BE an individual effort. Any academic dishonesty will result in zero marks in the corresponding exam or evaluation and will be reported to the department council for record keeping and for permission to assign F grade in the course. The department policy on academic integrity can be found at: <https://minerva.nitc.ac.in/?q=node/650>.

QUESTIONS

1. Red-Black Tree in Assignment 2.
2. Write a program to create an a Binary Min Heap H and perform the following operations.(Assume that the Binary Min Heap does not contain duplicate values.)
 - FIND-MIN(H) - returns the element of H with the smallest key.
 - EXTRACT-MIN(H) - removes and returns the element of H with the smallest key.
 - DECREASE-KEY(H, x, k) -decrease the value of element x's key to the new value k, which is assumed to be less than x's current key value for a successful completion of the operation.
 - INSERT(H, x) - add a new key x at the end of the heap. If the new key is greater than its parent, then we don't need to do anything. Otherwise, we need to traverse up to fix the violated heap property.
 - DELETE(H,x) -replace the key to be deleted with minus infinity by calling DECREASE-KEY() function. After DECREASE-KEY(), the minus infinity value must reach the root. Subsequently, call EXTRACT-MIN() function to remove the desired key.

Input Format:

- Each line contains a character *i, d, p, x, r, g* and *e*, followed by at most two integers. The integers, if given, are in the range $[-10^6, 10^6]$.
- *i k*- inserts k into the heap.
- *d k*- deletes the node with key k from the heap and prints the deleted node's key. If k is not present, prints -1.
- *p* - prints the heap.
- *x* - extracts the minimum element and prints the heap.
- *r y z*- decreases the value of the node with key y to z and prints the decreased value. If $z \geq y$, then print -1.
- *g* - returns the minimum of H
- *e*- 'exit' from the program.

Output Format:

- The output (if any) of each command should be printed on a separate line.

Sample Input:

```
i 20
p
i 15
p
i 30
p
i 10
p
g
d 20
r 30 25
p
x
e
```

Sample Output:

```
20
15 20
```

```
15 20 30
10 15 30 20
10
20
25
10 15 25
15 25
```

3. A Binary Heap is a Binary Tree with following properties. It's a complete tree (All levels are completely filled except possibly the last level and the last level has all keys as left as possible). A Binary Heap is either Min Heap or Max Heap. In a Min Binary Heap, the key at root must be minimum among all keys present in Binary Heap. The same property must be recursively true for all nodes in Binary Tree. Max Binary Heap is similar to MinHeap.

Write a program for printing K largest elements in an array. Elements in an array can be in any order. Use MinHeap/Max-Heap DataStructure for the given problem.

Input Format:

- First line consists of a number of test cases.
- The next line denotes n - size of the array.
- The next line has n numbers.
- The next line consists of 'K'.

Output Format:

- K required values.

Input 1:

```
1
7
1 23 12 9 30 2 50
3
```

Output 1:

```
50 30 23
```

Input 2:

```
2
7
11 5 12 9 44 17 2
2
3
12 13 14
2
```

Output 2:

```
44 17
14 13
```

4. Given N ropes of different lengths, connect these ropes into one rope with minimum cost, such that the cost to connect two ropes is equal to the sum of their lengths. Return the total cost of connecting all the ropes. Use priority queue using linked list to solve this problem.

Input Format:

- First line contains an integer, N.
- Second line contains N integers, the length of N ropes, separated by a space.

Output Format:

- Return the total cost of connecting all the ropes.

Input 1:

4
4 3 2 6

Output 1:

29

Input 2:

3
1 2 3

Output 2:

9