National Institute of Technology Calicut
Department of Computer Science and Engineering
Fourth Semester B. Tech.(CSE)-Winter 2021-22
CS2094D Data Structures Laboratory
Assignment #4

Submission deadline (on or before): 21.03.2022, 9:00 AM

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>_<FIRST-NAME>.zip`

  (Example: $ASSG1\_BxxyyyyCS\_LAXMAN.zip$). 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>_<FIRST-NAME>_<PROGRAM-NUMBER>.c`

  (For example: $ASSG1\_BxxyyyyCS\_LAXMAN\_1.c$). 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: http://cse.nitc.ac.in/sites/default/files/Academic-Integrity_new.pdf.

QUESTIONS

1. Write a program to implement a BINOMIAL HEAP and perform the operations *insertion*, *deletion*, *extract_minimum* and *union*. Your program should contain the following functions:

   - MAKEHEAP() - Creates and returns a new heap H containing no elements.
   - INSERT(H, x) – Inserts a new node with key 'x' into the heap H.
   - MINIMUM(H) – Return the value of the smallest key in the heap H.
   - EXTRACTMIN(H) – Deletes the node with minimum key value from heap H and prints the deleted node.
   - DECREASEKEY(H, x, k) – If the node of H with key 'x' is at least 'k', then decreases the value of node with key 'x' by 'k'. Otherwise, it prints -1.
   - DELETE(H, x) - Deletes the node with key 'x' from the heap H. If node is present, it prints the deleted node else it prints -1.
   - UNION(H_1, H_2) - Create and return a new heap H that contains all the nodes of heaps H_1 and H_2. Heaps H_1 and H_2 are "destroyed" by this operation.

   Input Format:

   - Each line contains a character from 'i', 'm', 'x', 'r', 'd' and 'e' followed by at most one integer. 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 print the deleted node's key.
   - p - prints the binomial heap
   - m - prints the minimum element in the binomial heap (Note:- In print function, level order traversal is to be used).
   - x - extracts and prints the minimum element from the heap
   - r y z - decreases the value of node with key y by z.
   - e - 'exit' from the program.

   Output Format:

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

   Sample Input:

   ```
   i 10
   i 20
   i 30
   i 40
   i 50
   p
   m
   x
   p
   r 50 4
   p
   r 70 5
   ```

   Sample Output:

   ```
   50 10 30 20 40
   10
   10
   20 30 50 40
   46
   20 30 46 40
   -1
   ```