National Institute of Technology Calicut
Department of Computer Science and Engineering
Third Semester B. Tech.(CSE)
CS2092D Programming Laboratory
Assignment #5 Part A
Submission deadline (on or before): 18/09/2023, 8:30 PM

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: *ASSG5A_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: *ASSG5_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.

General Instructions

- Programs should be written in C language.
- Check your programs with sufficiently large values of inputs with in the range as specified in the question.
- Global and/or static variables should not be used in your program.

QUESTIONS

1. Write a program that uses the MERGE-SORT algorithm for sorting a given input sequence of integers present in an array A. Your program must contain the following functions. (In what follows, the notation $A[p..r]$ denotes the sub-array of A, contained within the p^{th} and r^{th} indices, both inclusive.)
   - A recursive function MERGE-SORT($A,\ p,\ r$) that takes as input an array A and sorts the elements in the sub-array $A[p..r]$.
   - A function MERGE($A,\ p,\ q,\ r$) that takes as input an array A in which the sub-arrays $A[p..q]$ and $A[q+1..r]$ are sorted. It then merges these sub-arrays such that the sub-array $A[p..r]$ is sorted.
   - PRINT(A, n) - A function that takes as input an array A, the size of the array, and prints its contents in order, with a single space separating the elements. This function should only be called from the MAIN() function.

Input format:

- The first line of the input contains an integer $n \in [0, 10^5]$, the size of the array A.
- The second line lists the n elements in A, as space-separated integers in the range $[-10^3, 10^3]$.

Output Format:

- The first line of the output contains the elements of A in sorted order, separated by space.

Note:

- In particular, to split an array $A[p..r]$ into two sub-arrays, the MERGE-SORT() function should compute an index $q \in [p, r]$ such that $A[p..q]$ contains $\lceil n/2 \rceil$ elements, and $A[q+1..r]$ contains $\lfloor n/2 \rfloor$ elements).

Sample Input 1:

10
23 76 89 3 8 0 789 123 889 25

Samle Output 1:

0 3 8 23 25 76 89 123 789 889

Sample Input 2:

10
90 89 78 67 56 45 34 23 12 11

Sample Output 2:

11 12 23 34 45 56 67 78 89 90

2. Write a program that uses the HEAP-SORT algorithm for sorting a given input sequence of integers present in an array A in non-decreasing order. Your program must contain the following functions: (the notation $A[i..j]$ denotes the sub-array of A, contained within the i^{th} and j^{th} indices, both inclusive).

   - A recursive function MAX-HEAPIFY(A, i) that takes as input an array A and lets the value at $A[i]$ "float down" in the max-heap so that the subtree rooted at index i obeys the max-heap property.
   - A function BUILD-MAX-HEAP(A) that takes as input an array A and build a max-heap on the input array $A[1...n]$ where n is equal to $A.length$.
   - A function HEAPSORT(A) that takes as input an array A and sorts an array A in place.

   Input format:

   - The first line of the input contains an integer $n \in [1, 10^5]$, the size of the array A.
   - The second line lists the n elements in A, as space-separated integers in the range $[-10^3, 10^3]$.

   Output Format:

   - The first line of the output contains the elements of A in sorted order, separated by space.

   Sample Input:

   8
   98 67 56 45 43 23 20 12

Sample Output:

12 20 23 43 45 56 67 98