Points: 100/100 Due Date: Nov. 3, 2021

Submission Notes:

1. Please upload your submission in PDF format. If the submitted solution is hand-written and scanned, it must be clear, clean, and high resolution.
2. Submit all assigned homework problems since only selected problems will be graded.
3. The completeness of the answer will be evaluated as well as its correctness. So please show your work to receive credit.
4. Your answers' sheet(s) should be different from the homework assignment's sheets, i.e., do not have the answers on the assignment's sheets.
5. If the assignment requires a code submission, not a code snippet, the only files you submit for the code should be the source files. Do not submit any zip or compressed files, binary files, or any other generated files. Do not put the code inside the PDF file. Submission of unnecessary files or binary files in addition to source files will make you lose the points of the assignment. The code must have the following:
    a. Use of descriptive names for the identifiers and active names for functions.
    b. Use consistent indentation through your code.
    c. Use consistent braces style through your code.
    d. Efficient utilization of functions. Make sure to reduce (*keep functions as simple as you can make them*) and reuse (*create functions for repeated parts of the code*) your code.
    e. File-level comments, these comments will include the file name, your name, section number, and date of last modification. In addition, these comments must have instructions on how we run the program and test it.
    f. Function level comments include the function's description, the function's parameters, and the function's return value. These comments will appear before each of the functions, not the prototypes.
    g. In function comments, these comments will include a description of the atomic functionalities within the bodies of the functions.

Probelm 1: (55 points)

Using the C++ STL vector class, implement a **Queue** class and a **Stack** class.

- The **Stack** class must have the `push()`, `pop()`, `size()`, `top()`, and `print()` member functions.
- The **Queue** class should have the `enqueue()`, `dequeue()`, `size()`, `first()`, and `print()` member functions.
- Write test programs to test each of the Stack and Queue classes by adding several values to objects of each class. The test programs should invoke all the public member functions of the tested class. The output of the test programs should show what the program performs and demonstrate that all the public member functions are functional.

Note: The `print()` member functions should print all the Queue elements or the stack elements.

Probelm 2: (45 points)

1. Write a recursive `C++` function `countTheOnes()` to count a recursive function to count the number of `1`'s in the binary representation of a `uint64_t` integer.

2. Write a recursive `C++` function that return a vector of the negative numbers that exist in a vector `V`.

3. Write a recursive C++ function that when given the two positive integers `x` and `y` where `x<y`, it will print a pattern that contains the counting from `x` to `y`, and then count down back again to `x`. For example, when the function is given `x=10` and `y=15`, then the function call will print the following pattern `10 11 12 13 14 15 14 13 12 11 10`.

Note: Make sure to include the test programs and to identify the base case(s).