1. (10%) The Fibonacci numbers (0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, ...) are defined by the recurrence:

$$F_0 = 0$$
$$F_1 = 1$$
$$F_i = F_{i-1} + F_{i-2} \text{ for all } i \geq 2$$

Write a **non-recursive** program to calculate the Fibonacci Numbers. Your program should output the Fibonacci number for each input value in one per line.

Sample Input

5
7

Sample Output

The Fibonacci number for 5 is 5
The Fibonacci number for 7 is 13

2. (10%) Show the operation of merge sort on the array $A=\{7, 3, 5, 2, 4, 6, 1, 9, 8\}$. Please also explain that $O(n \log n)$ is the solution to the recurrence for merge sort, where n is the size of the input array.

3. (10%) The following graph represents a network, where the numbers represent the time delays across a link.
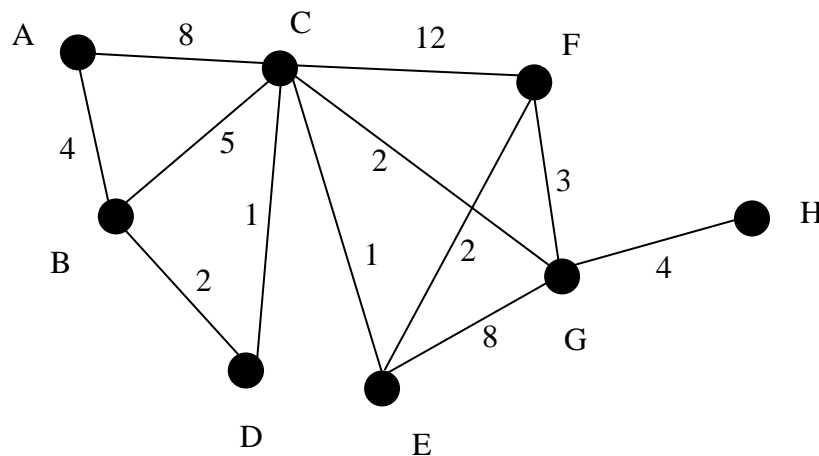
(a) Explain how to find a minimum cost spanning tree for the above graph? (5%)
(b) Explain how to find a depth-first-search tree with source F on the graph. (5%)

4. (10%) Show the running time of quicksort when all elements of array A have the same value. Also show the running time of quicksort when the array A is sorted in non-increasing order.

5. (10%) The greatest common divisor of integers x and y is the largest integer that evenly divides both x and y. Write a recursive function that returns the greatest common divisor of x and y.

6. (10%) Please answer the following problems:
   (a) Given a binary number $(10100101)_2$, what are the unsigned number, 1's complement number and 2's complement number, respectively? (5%)
   (b) By using IEEE 754 standard representation, how to represent the number -121.625. (5%)

7. (10%) For the following gate sets, what are the functionally complete sets? If the answer is "Yes", please give the detailed explanation for the functionally complete set.
   (a) { AND, NOT }(5%)
   (b) { NAND, OR} (5%)

8. (10%) For an adder design, please answer the following problems:
   (a) Draw the gate circuit of a half adder for two bits. (5%)
   (b) Draw the gate circuit of a full adder based on the circuit module in (a) and necessary gates. (5%)

9. (20%) Explain the following problems in modern computers
   (a) Explain why L1 cache is divided into D-cache and I-cache (5%)
   (b) Explain why the processors in most of portable devices are RISC (5%)
   (c) Explain the difference between RAMs and flash ROMs(5%)
   (d) Explain the disadvantages of cache memory and virtual memory(5%)