AlgoLab 1

1. (CLRS page no. 879) Write a C or a C++ program for modular exponentiation in $O(log\ n)$ time. You have to find the value of $a^x\ mod\ n$ where a, x and n are integer. You shold not multiply a, n times. This way it takes $O(n)$ time.

2. Write a C or a C++ program to find GCD of two numbers. Write a C or a C++ program for function GCD for more than two arguements by the recursive equation $\text{GCD}(a_1, a_2, a_3, ..., a_n) = \text{gcd}(a_1, gcd(a_2, a_3, ...a_n))$.

3. The numbers x and y are relatively prime and therefore there must exist integers a and b such that $xa + yb = 1$. Write a program to find such a pair of integers (a, b) with the smallest possible $a > 0$. Given this pair, can you determine the inverse of x mod y?

4. Randomized algorithms : algorithm which may return wrong answer with some non-negligible probability. Miller Rabin alogithm is primality testing algorithm (whether the number n is prime or not) which is based on Fermat's theorem. You have to write a program for Miller Rabin alogithm. Check $n = 2047 = 23 \times 89$ with $a = 2$. (CLRS page no. 891)

5. Let p(x) be a polynomial of degree n. Write a C or C++ program for Horners rule to calculate the value of the polynomial. (CLRS 39)

6. Given is a fixed, ordered (by $\leq$) array $b[0 : n-1]$, where $n > 0$. A plateau of the array is a sequence of equal values. Write a program to find the length of longest plateau of $b[0 : n-1]$.

7. Given a set S of n integers and another integer x. Write a C or C++ program for a $\theta(nlgn)$ time algorithm that determines whether or not there exist two elements in S whose sum is exactly x.

8. Given a set S of n integers, write a C or C++ program to find two integer which are closest. For example $\{20, 1, 100, 13, 16, 2, 5, 7\}$, closest pair is $\{1, 2\}$. Hint: first sort.

Note: Find the time complexity of all above algorithms.