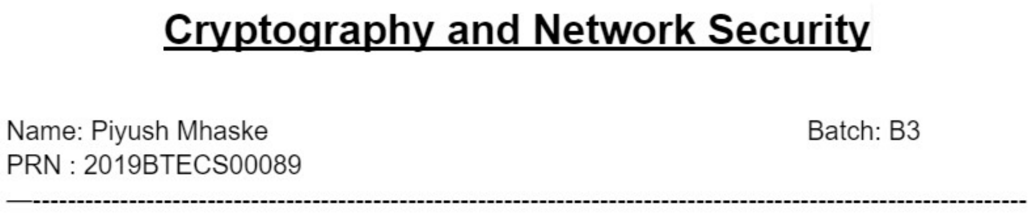

Cryptography and Network Security

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RSA Algorithm

Problem statement :

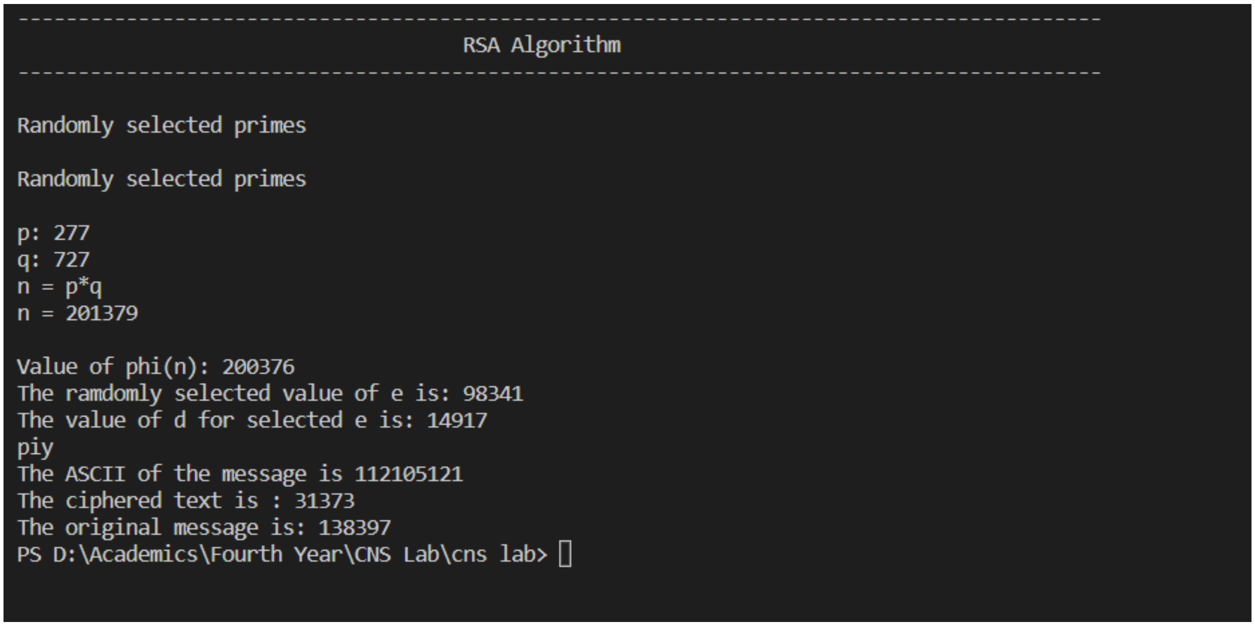
Cipher your name using RSA

```
#include <bits/stdc++.h>
#define N 1000
using namespace std;

long long power(long long a, long long b, long long mod){
    long long result = 1;
    while(b > 0){
        // check if the last bit is odd
        if(b&1)
            result = (result*a)%mod;
        a = (a*a)%mod;
        // b /= 2
        b >>= 1;
    }
    return result;
}
long long convertToASCII(string letter){

    long long ans = 0;
    string str;
    if(letter.length() > 9){
        cout<<"provide input with 3 letters";
        return 0;
    }
    for (int i = 0; i < letter.length(); i++)
    {
        int x = letter[i];
        str = str + to_string(x);
    }

    return (long long)stoi(str);
}
```

```
long long gcdExtended(long long a, long long b, long long *x, long long *y)
{
  // cout << a << " " << b << " "<< " " << *x << " " << *y << "\n";
  // Base Case
  if (b == 0)
  {
    return *x;
  }
  long long q = a / b;
  long long x1 = *y;
  long long y1 = *x - q * (*y);
  long long t1 = gcdExtended(b, a % b, &x1, &y1);

  // cout << a << " " << *x << "\n";
  if (*x == 0 && t1 < 0)
    return a + t1;
  else
    return t1;

  // return gcd;
}

void SieveOfEratosthenes(int n, vector<int> &primes) {

    bool prime[n + 1];
    memset(prime, true, sizeof(prime));

    for(int p = 2; p * p <= n; p++) {
        if (prime[p]) {
            for (int i = p * p; i <= n; i += p)
                prime[i] = false;
        }
    }
    for (int p = 2; p <= n; p++)
        if (prime[p]){
            primes.push_back(p);
        }

}


int main() {

    char patternChar = '-';
    char resetChar = ' ';
    int lineWidth = 90;
    int initialWidth = 50;

    cout << setfill(patternChar) << setw(lineWidth) << patternChar << endl;
    cout << setfill(resetChar);
    cout << setw(initialWidth) << "RSA Algorithm" << endl;
    cout << setfill(patternChar) << setw(lineWidth) << patternChar << endl;
    cout << setfill(resetChar);
```

```
vector<int> primes;
// generating primes between 1 and N;
SieveOfEratosthenes(N, primes);

srand(time(0));
// choose any two primes randomly
int p, q;
int primesSize = primes.size();
int rand = std::rand();
p = primes[(rand % primesSize)];
do{
    rand = std::rand();
    q = primes[(rand % primesSize)];
}while(p == q);

cout << "\nRandomly selected primes\n" << endl;
cout << "p: " << p << endl;
cout << "q: " << q << endl;

// calculate the value of n
long long n = p*1LL*q;
cout << "n = p*q" << endl;
cout << "n = " << n << endl;


// calculate the value of phi
long long phi = (p-1)*1LL*(q-1);
cout << "\nValue of phi(n): " << phi << endl;

// generating all the co-primes between 2 and phi👎
// acquire prime (a) such that a*a < phi value
// store them

vector<int> primeList;
for(size_t i = 0; i < primes.size(); i++){
    if(primes[i]*1LL*primes[i] <= phi){
        primeList.push_back(primes[i]);
    }
}

// find the factors of unique prime factors of phu value
vector<int> phiPrimeList;
for(size_t i =0; i < primeList.size(); i++){
    if(phi > primeList[i] && (phi % primeList[i] == 0)){
        phiPrimeList.push_back(primeList[i]);
        while(phi % primeList[i] == 0){
            phi /= primeList[i];
        }
    }
}

if(phi > 1){
    phiPrimeList.push_back(phi);
}

// reassining the value of phi
phi = (p-1)*1LL*(q-1);
long long sizeRestriction  = 1e6;

sizeRestriction = min(sizeRestriction, phi);

// note : We are restricting the random coPrime upto 1e6
vector<int> coPrimesOfPhi;

vector<bool> phiVec(sizeRestriction, true);
phiVec[0] = phiVec[1] = false;

for(auto prime : phiPrimeList){
    for(int i = prime; i < sizeRestriction; i += prime){
        phiVec[i] = false;
    }
}

for(size_t i = 0; i < phiVec.size(); i++){
    if(phiVec[i])
        coPrimesOfPhi.push_back(i);
}

// cout << "Co-Primes between [2,maxLimit of restriction) are as follows: " << endl;

// for(size_t i = 0; i < coPrimesOfPhi.size(); i++){
//     cout << coPrimesOfPhi[i] << " ";
// }
// cout << endl;

// avoiding selecting the first or any specific number of coprime which occured

rand = std::rand();
int e = coPrimesOfPhi[rand%coPrimesOfPhi.size()];
cout << "The ramdomly selected value of e is: " << e << endl;

long long x,y;
x=0;
y=1;
int d = gcdExtended(phi, e, &x, &y);
cout << "The value of d for selected e is: " << d << endl;

// message to be encrypted

string str;
cin>>str;
long long msg = convertToASCII(str);
cout<<"The ASCII of the message is "<<msg<<"\n";

long long c = power(msg,e,n);
cout<<"The ciphered text is : "<<c<<"\n";
long long org = power(c,d,n);
cout<<"The original message is: "<<org<<"\n";


return 0;
}
```

Output:



```
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                                     RSA Algorithm
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Randomly selected primes

Randomly selected primes

p: 277
q: 727
n = p*q
n = 201379

Value of phi(n): 200376
The ramdomly selected value of e is: 98341
The value of d for selected e is: 14917
piy
The ASCII of the message is 112105121
The ciphered text is : 31373
The original message is: 138397
PS D:\Academics\Fourth Year\CNS Lab\cns lab> 
```

Encrypting the first 3 letters of my name