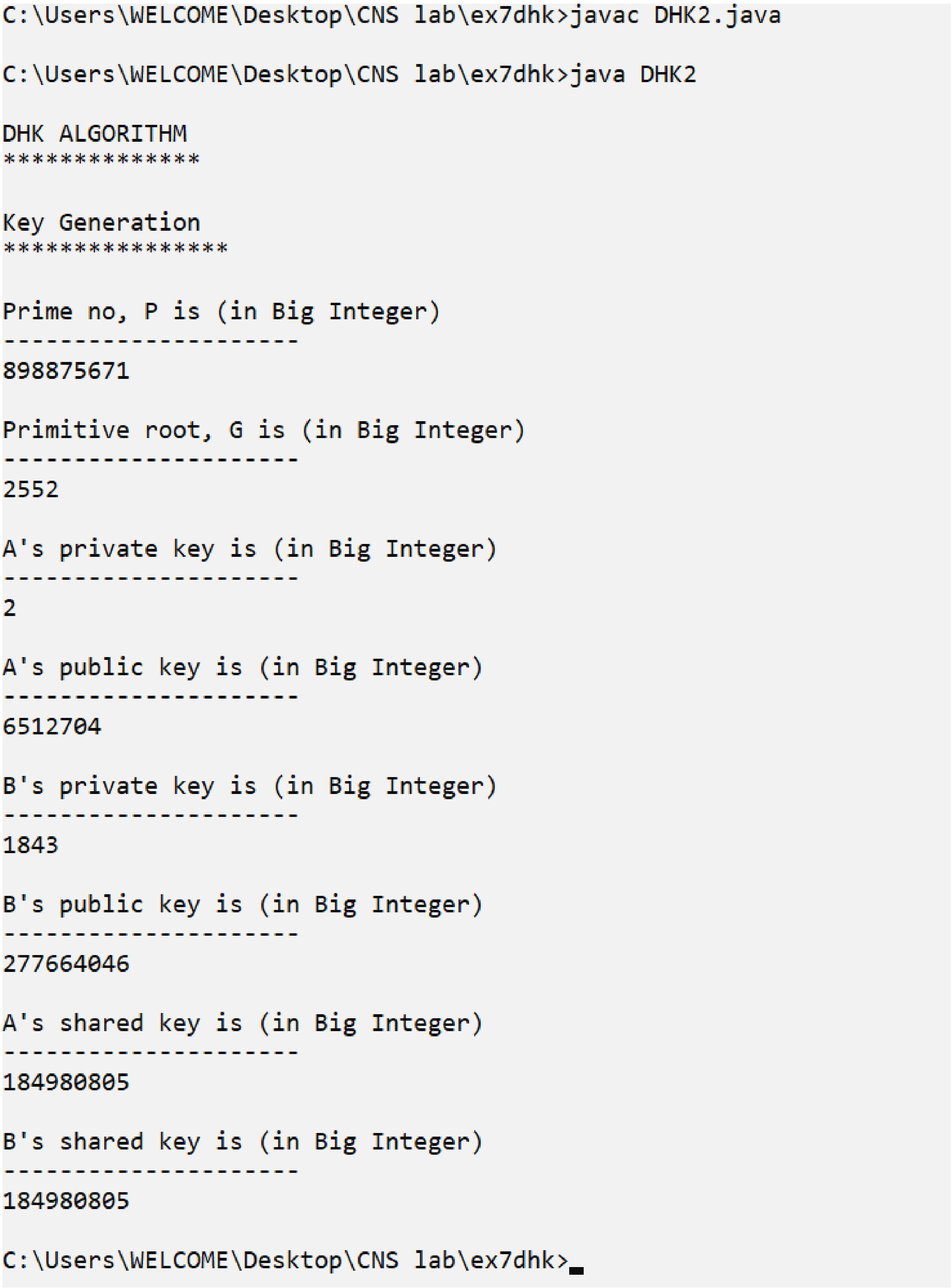
EX.NO.7 **DIFFIE HELLMAN KEY EXCHANGE ALGORITHM**

CODE:

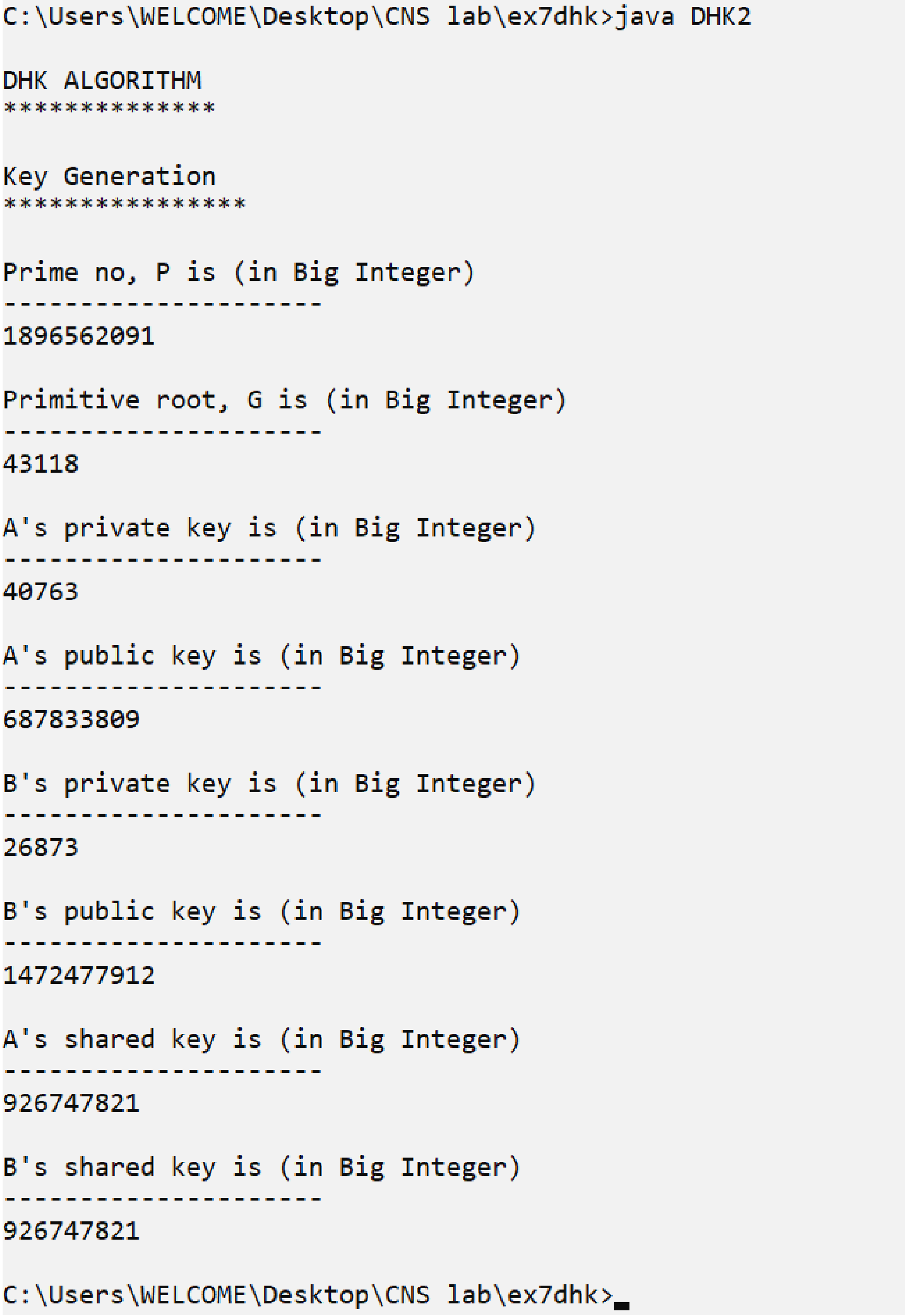
```
import java.io.IOException;
import java.math.BigInteger;
import java.util.*;

public class DHK2 {
  private BigInteger p;
  private BigInteger g;
  private BigInteger phi;
  private BigInteger Xa;
  private BigInteger Xb;
  private BigInteger Ya;
  private BigInteger Yb;
  private BigInteger Ka;
  private BigInteger Kb;

  private int bitlength = 32;
  private int noOfIterations = 5;
  private Random rand;

  private static final BigInteger ZERO = BigInteger.ZERO;
  private static final BigInteger ONE = BigInteger.ONE;
  private static final BigInteger TWO = new BigInteger("2");
  private static final BigInteger THREE = new BigInteger("3");
  private static final BigInteger FOUR = new BigInteger("4");

  public DHK2() {
    rand = new Random();
    generatePrime();
    getPrimitiveRoot();
  }

  public void getPrimitiveRoot() {
    phi = p.subtract(ONE);
    HashSet<BigInteger> primeFactors = getPrimeFactors();
    ArrayList<BigInteger> primitiveRoots = new ArrayList<>();

    for (BigInteger r = BigInteger.TWO;r.compareTo(phi) < 0;r =
r.add(BigInteger.ONE)) {
      boolean flg = false;
      for (BigInteger l : primeFactors) {
        BigInteger phiBig = phi.divide(l);
        BigInteger pRootBig = r.modPow(phiBig, p);
        if (pRootBig.compareTo(BigInteger.valueOf(1)) == 0) {
          flg = true;
          break;
        }
    }
    if (!flg) {
      primitiveRoots.add(r);
    }
  }
  g= primitiveRoots.get(new Random().nextInt(primitiveRoots.size()));
}

public HashSet<BigInteger> getPrimeFactors() {
  HashSet<BigInteger> primesFactors = new HashSet<>();

  while (phi.mod(TWO).signum() == 0) {
    primesFactors.add(TWO);
    phi = phi.divide(TWO);
  }

  for (BigInteger i = THREE; i.compareTo(phi.sqrt()) <= 0; i = i.add(TWO)) {
    if (phi.mod(i).signum() == 0) {
      primesFactors.add(i);
      phi = phi.divide(i);
    }
  }

  if (phi.compareTo(TWO) > 0) {
    primesFactors.add(phi);
  }
  return primesFactors;
}

void generatePrime() {
  byte[] b = new byte[bitlength / 8];
  rand.nextBytes(b);
  p = new BigInteger(b);
  while (!isPrime(p, noOfIterations)) {
    rand.nextBytes(b);
    p = new BigInteger(b);
  }
}

boolean miillerTest(BigInteger d, BigInteger n) {

  BigInteger maxLimit = n.subtract(TWO);
  BigInteger minLimit = TWO;
  BigInteger bigInteger = maxLimit.subtract(minLimit);
  int len = maxLimit.bitLength();
  BigInteger a = new BigInteger(len, rand);
  if (a.compareTo(minLimit) < 0) a = a.add(minLimit);
  if (a.compareTo(bigInteger) >= 0) a = a.mod(bigInteger).add(minLimit);

  BigInteger x = a.modPow(d, n);
  if (x.compareTo(ONE) == 0 || x.compareTo(n.subtract(ONE)) == 0) return true;

  while (d.compareTo(n.subtract(ONE)) != 0) {
    x = x.multiply(x).mod(n);
    d = d.multiply(TWO);

    if (x.compareTo(ONE) == 0) return false;
    if (x.compareTo(n.subtract(ONE)) == 0) return true;
  }
  return false;
}

boolean isPrime(BigInteger n, int k) {

  if (n.compareTo(ONE) <= 0 || n.compareTo(FOUR) == 0) return false;
  if (n.compareTo(THREE) <= 0) return true;

  BigInteger d = n.subtract(ONE);

  while (d.mod(TWO).signum() == 0) d = d.divide(TWO);

  for (int i = 0; i < k; i++) if (!miillerTest(d, n)) return false;

  return true;
}

void userAgen(){
  BigInteger maxLimit = g;
  BigInteger minLimit = ONE;
  BigInteger bigInteger = maxLimit.subtract(minLimit);
  int len = maxLimit.bitLength();
  Xa = new BigInteger(len, rand);
  if (Xa.compareTo(minLimit) < 0)
    Xa = Xa.add(minLimit);
  if (Xa.compareTo(bigInteger) >= 0)
    Xa = Xa.mod(bigInteger).add(minLimit);
  Ya=g.modPow(Xa,p);
}

void userBgen(){
  BigInteger maxLimit = g;
  BigInteger minLimit = ONE;
  BigInteger bigInteger = maxLimit.subtract(minLimit);
  int len = maxLimit.bitLength();
  Xb = new BigInteger(len, rand);
  if (Xb.compareTo(minLimit) < 0)
    Xb = Xb.add(minLimit);
  if (Xb.compareTo(bigInteger) >= 0)
    Xb = Xb.mod(bigInteger).add(minLimit);
    Yb=g.modPow(Xb,p);
  }

  void secretAgen(){
    Ka=Yb.modPow(Xa,p);
  }

  void secretBgen(){
    Kb=Ya.modPow(Xb,p);
  }

  public static void main(String[] args) throws IOException {
    Scanner sc = new Scanner(System.in);
    System.out.println("\nDHK ALGORITHM");
    System.out.println("**************");
    DHK2 dhk = new DHK2();

    System.out.println("\nKey Generation");
    System.out.println("****************");
    System.out.println("\nPrime no, P is (in Big Integer)");
    System.out.println("---------------------\n" + dhk.p);
    System.out.println("\nPrimitive root, G is (in Big Integer)");
    System.out.println("---------------------\n" + dhk.g);

    dhk.userAgen();
    System.out.println("\nA's private key is (in Big Integer)");
    System.out.println("---------------------\n" + dhk.Xa);
    System.out.println("\nA's public key is (in Big Integer)");
    System.out.println("---------------------\n" + dhk.Ya);

    dhk.userBgen();
    System.out.println("\nB's private key is (in Big Integer)");
    System.out.println("---------------------\n" + dhk.Xb);
    System.out.println("\nB's public key is (in Big Integer)");
    System.out.println("---------------------\n" + dhk.Yb);

    dhk.secretAgen();
    System.out.println("\nA's shared key is (in Big Integer)");
    System.out.println("---------------------\n" + dhk.Ka);

    dhk.secretBgen();
    System.out.println("\nB's shared key is (in Big Integer)");
    System.out.println("---------------------\n" + dhk.Kb);
  }
}
```

Example 1:



```
C:\Users\WELCOME\Desktop\CNS lab\ex7dhk>javac DHK2.java

C:\Users\WELCOME\Desktop\CNS lab\ex7dhk>java DHK2

DHK ALGORITHM
**************

Key Generation
****************

Prime no, P is (in Big Integer)
---------------------
898875671

Primitive root, G is (in Big Integer)
---------------------
2552

A's private key is (in Big Integer)
---------------------
2

A's public key is (in Big Integer)
---------------------
6512704

B's private key is (in Big Integer)
---------------------
1843

B's public key is (in Big Integer)
---------------------
277664046

A's shared key is (in Big Integer)
---------------------
184980805

B's shared key is (in Big Integer)
---------------------
184980805

C:\Users\WELCOME\Desktop\CNS lab\ex7dhk>
```

Example 2:



```
C:\Users\WELCOME\Desktop\CNS lab\ex7dhk>java DHK2

DHK ALGORITHM
**************

Key Generation
****************

Prime no, P is (in Big Integer)
---------------------
1896562091

Primitive root, G is (in Big Integer)
---------------------
43118

A's private key is (in Big Integer)
---------------------
40763

A's public key is (in Big Integer)
---------------------
687833809

B's private key is (in Big Integer)
---------------------
26873

B's public key is (in Big Integer)
---------------------
1472477912

A's shared key is (in Big Integer)
---------------------
926747821

B's shared key is (in Big Integer)
---------------------
926747821

C:\Users\WELCOME\Desktop\CNS lab\ex7dhk>
```