Assignment 3

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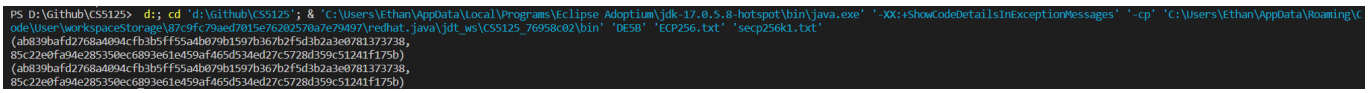
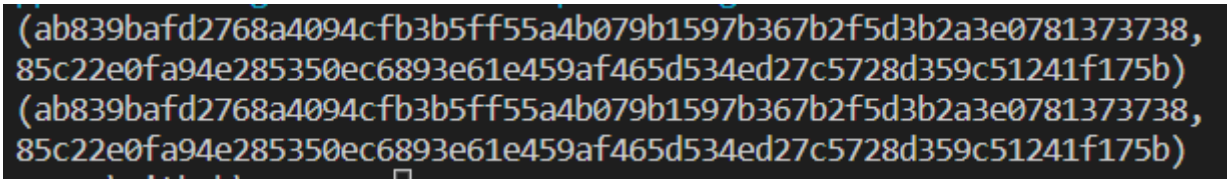
Output





Code

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

class Point {

  public BigInteger x;
  public BigInteger y;
  static Point O = new Point(null, null);

  public Point(BigInteger xx, BigInteger yy) {
    x = xx;
    y = yy;
  }

  public String toString() {
    return this.equals(O)
      ? "O"
      : "(" + x.toString(16) + ",\n" + y.toString(16) + ")";
  }
}

public class DE5B {

  static BigInteger three = new BigInteger("3");
  static final int privateKeySize = 255;
  BigInteger p; // modulus
  Point G; // base point
  BigInteger a; // curve parameter
  BigInteger b; // curve parameter
  BigInteger n; // order of G
  BigInteger privateKeyA;
  Point publicKeyA;
```

```
  BigInteger privateKeyB;
  Point publicKeyB;
  Random random = new Random();

  void readCurveSpecs(String filename) {
    Scanner in = null;
    try {
      in = new Scanner(new File(filename));
    } catch (FileNotFoundException e) {
      System.err.println(filename + " not found");
      System.exit(1);
    }
    p = new BigInteger(in.nextLine(), 16);
    n = new BigInteger(in.nextLine(), 16);
    a = new BigInteger(in.nextLine(), 16);
    b = new BigInteger(in.nextLine(), 16);
    G =
      new Point(
        new BigInteger(in.nextLine(), 16),
        new BigInteger(in.nextLine(), 16)
      );
    in.close();
  }

  Point add(Point P1, Point P2) {
    if (P1.equals(Point.O)) return P2;
    if (P2.equals(Point.O)) return P1;
    if (P1.x.equals(P2.x)) if (P1.y.equals(P2.y)) return selfAdd(
      P1
    ); else return Point.O;
    BigInteger t1 = P1.x.subtract(P2.x).mod(p);
    BigInteger t2 = P1.y.subtract(P2.y).mod(p);
    BigInteger k = t2.multiply(t1.modInverse(p)).mod(p); // slope
    t1 = k.multiply(k).subtract(P1.x).subtract(P2.x).mod(p); // x3
    t2 = P1.x.subtract(t1).multiply(k).subtract(P1.y).mod(p); // y3
    return new Point(t1, t2);
  }

  Point selfAdd(Point P) {
    if (P.equals(Point.O)) return Point.O; // O+O=O
    if (P.y.equals(BigInteger.ZERO)) return Point.O;
    BigInteger t1 = P.y.add(P.y).mod(p); // 2y
    BigInteger t2 = P.x.multiply(P.x).mod(p).multiply(three).add(a).mod(p); //
3xx+a
    BigInteger k = t2.multiply(t1.modInverse(p)).mod(p); // slope or tangent
    t1 = k.multiply(k).subtract(P.x).subtract(P.x).mod(p); // x3 = kk-x-x
    t2 = P.x.subtract(t1).multiply(k).subtract(P.y).mod(p); // y3 = k(x-x3)-y
    return new Point(t1, t2);
  }

  Point multiply(Point P, BigInteger n) {
    if (n.equals(BigInteger.ZERO)) return Point.O;
    int len = n.bitLength(); // position preceding the most significant bit 1
    Point product = P;
```

```
    for (int i = len - 2; i >= 0; i--) {
      product = selfAdd(product);
      if (n.testBit(i)) product = add(product, P);
    }
    return product;
  }

  void checkParameters() {
    BigInteger lhs = G.y.multiply(G.y).mod(p);
    BigInteger rhs = G.x
      .modPow(three, p)
      .add(G.x.multiply(a).mod(p))
      .add(b)
      .mod(p);
    System.out.println(lhs.toString(16));
    System.out.println(rhs.toString(16)); // These two lines should be the same
    Point power = multiply(G, n);
    System.out.println(power); // This should be O
  }

  void generateKeys() {
    privateKeyA = new BigInteger(privateKeySize, random);
    publicKeyA = multiply(G, privateKeyA);
    privateKeyB = new BigInteger(privateKeySize, random);
    publicKeyB = multiply(G, privateKeyB);
  }

  void sharedSecret() { // Figure 10.7 of book
    Point KA = multiply(publicKeyB, privateKeyA); // secret computed by A
    Point KB = multiply(publicKeyA, privateKeyB); // secret computed by B, your
code
    System.out.println(KA);
    System.out.println(KB);
  }

  public static void main(String[] args) {
    if (args.length < 1) {
      System.err.println("Usage: java DE5B ECP256.txt/secp256k1.txt");
      return;
    }
    DE5B de5 = new DE5B();
    de5.readCurveSpecs(args[0]);
    de5.generateKeys();
    de5.sharedSecret();
  }
}
```