



Department of CSE

Laboratory Manual	
Course:	B.Tech.
Year & Semester:	IV – I
Class:	CSE
Subject:	Cryptography and Network Security Lab Manual
Regulation:	R22

BALAJI INSTITUTE OF TECHNOLOGY AND SCIENCE (AUTONOMOUS)

B.Tech (Department of Computer Science & Engineering)

CRYPTOGRAPHY AND NETWORK SECURITY LAB

Course Outcomes:

- Understand basic cryptographic algorithms, message and web authentication and security issues.
- Identify information system requirements for both of them such as client and server.
- Understand the current legal issues towards information security.
- Implement cryptographic algorithms like DES, Blowfish, Rijndael (AES), and RSA in C and Java.
- Compute message digests using SHA-1 and MD5 in Java for data integrity verification.

List of Experiments:

1. Write a C program that contains a string (char pointer) with a value 'Hello world'. The program should XOR each character in this string with 0 and display the result.
2. Write a C program that contains a string (char pointer) with a value 'Hello world'. The program should AND or and XOR each character in this string with 127 and display the result.
3. Write a Java program to perform encryption and decryption using the following algorithms.
a. Caesar cipher b. Substitution cipher c. Hill Cipher
4. Write a C/JAVA program to implement the DES algorithm logic.
5. Write a C/JAVA program to implement the Blowfish algorithm logic.
6. Write a C/JAVA program to implement the Rijndael algorithm logic.
7. Write the RC4 logic in Java Using Java cryptography; encrypt the text "Helloworld" using Blowfish. Create your own key using Java key tool.
8. Write a Java program to implement the RSA algorithm.
9. Implement the Diffie-Hellman Key Exchange mechanism using HTML and JavaScript.
10. Calculate the message digest of a text using the SHA-1 algorithm in JAVA.
11. Calculate the message digest of a text using the MD5 algorithm in JAVA.

I. XOR a string with a Zero

AIM: Write a C program that contains a string (char pointer) with a value \Hello World'. The program should XOR each character in this string with 0 and display the result.

PROGRAM:

```
#include<stdlib.h>
main()
{
char str[]="Hello World"; char
str1[11];
int i,len;
len=strlen(str);
for(i=0;i<len;i++)
{
str1[i]=str[i]^0;
printf("%c",str1[i]);
}
printf("\n");
}
```

Output: Hello
World Hello
World

2. XOR a string with a 127

AIM: Write a C program that contains a string (char pointer) with a value 'Hello World'. The program should AND or and XOR each character in this string with 127 and display the result.

PROGRAM:

```
#include <stdio.h>
#include<stdlib.h>
void main()
{
    char str[]="Hello World";
    char str1[11];
    char str2[11]=str[];
    int i,len;
    len = strlen(str);
    for(i=0;i<len;i++)
    {
        str1[i]=str[i]&127;
        printf("%c",str1[i]);
    }
    printf("\n");
    for(i=0;i<len;i++)
    {
        str3[i]=str2[i]^127;
        printf("%c",str3[i]);
    }
    printf("\n");
}
```

Output:

Hello World

Hello World

Hello World

3. Encryption & Decryption using Cipher Algorithms

AIM: Write a Java program to perform encryption and decryption using the following algorithms:

- a) Ceaser Cipher
- b) Substitution Cipher
- c) Hill Cipher

PROGRAM:

a) Ceaser Cipher

```
import java.io.BufferedReader;
import java.io.IOException;
import java.io.InputStreamReader;
import java.util.Scanner;
public class CeaserCipher {

    static Scanner sc=new Scanner(System.in);
    static BufferedReader br = new BufferedReader(new InputStreamReader(System.in)); public
    static void main(String[] args) throws IOException {

        // TODO code application logic here

        System.out.print("Enter any String: "); String
            str = br.readLine();

        System.out.print("\nEnter the Key: "); int key
            = sc.nextInt();

            String encrypted = encrypt(str, key);
        System.out.println("\nEncrypted String is: " +encrypted);

            String decrypted = decrypt(encrypted, key);
        System.out.println("\nDecrypted String is: "
            +decrypted); System.out.println("\n");
        }

        public static String encrypt(String str, int key)

            { String encrypted = "";
        for(int i = 0; i < str.length(); i++) { int c
```

```

    = str.charAt(i);
    if (Character.isUpperCase(c)) {
        c = c + (key % 26);
        if (c > 'Z')
            c = c - 26;
    }

    else if (Character.isLowerCase(c)){
        c = c + (key % 26);
        if (c > 'z')
            c = c - 26;
    }

    encrypted += (char) c;
}

return encrypted;
}

public static String decrypt(String str, int key)
{
    String decrypted = "";
    for(int i = 0; i < str.length(); i++) {
        int c = str.charAt(i);
        if (Character.isUpperCase(c)) {
            c = c - (key % 26);
            if (c < 'A')
                c = c + 26;
        }

        else if (Character.isLowerCase(c)){
            c = c - (key % 26);
            if (c < 'a')
                c = c + 26;
        }
    }
}

```

Output:

Enter any String: Hello World

Enter the Key: 5

Encrypted String is: MjqqtBtwqi

Decrypted String is: Hello World

b) Substitution Cipher

PROGRAM:

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

public class SubstitutionCipher{
    static Scanner sc = new Scanner(System.in);
    static BufferedReader br = new BufferedReader(new InputStreamReader(System.in)); public
    static void main(String[] args) throws IOException {
        // TODO code application logic here String a
        = "abcdefghijklmnopqrstuvwxyz"; String b =
        "zyxwvutsrqponmlkjihgfedcba";

        System.out.print("Enter any string: "); String
            str = br.readLine();
            String decrypt = "";
        char c;
        for(int i=0;i<str.length();i++)
            {
                c = str.charAt(i); int
                j = a.indexOf(c);
                decrypt = decrypt+b.charAt(j);
            }
        System.out.println("The encrypted data is: " +decrypt);
    }
}
```

Output:

Enter any string: aceho

The encrypted data is: zxvsl

a) HillCipher

PROGRAM:

```
import java.io.*; import
java.util.*; import
java.io.*; public class
HillCipher {
static float[][] decrypt = new float[3][1];
static float[][] a = new float[3][3]; static
float[][] b = new float[3][3]; static float[][]
mes = new float[3][1]; static float[][] res =
new float[3][1];
static BufferedReader br = new BufferedReader(new InputStreamReader(System.in));
static Scanner sc = new Scanner(System.in); public static void main(String[] args)
throws IOException {
    // TODO code application logic here
    getkeymes();
    for(int i=0;i<3;i++) for(int j=0;j<1;j++) for(int
    k=0;k<3;k++) { res[i][j]=res[i][j]+a[i][k]*mes[k][j];
    } System.out.print("\nEncrypted string is : ");
    for(int i=0;i<3;i++)
    { System.out.print((char)(res[i][0]%26+97));
    res[i][0]=res[i][0];

    }
    inverse();
    for(int i=0;i<3;i++)
    for(int j=0;j<1;j++)
    for(int k=0;k<3;k++) {
    decrypt[i][j] = decrypt[i][j]+b[i][k]*res[k][j]; }
    System.out.print("\nDecrypted string is : ");
```

```

for(int
i=0;i<3;i++){ System.out.print((char)(decrypt[i][0]%
26+97));
    }

System.out.print("\n");
    }

public static void getkeymes() throws IOException { System.out.println("Enter 3x3
matrix for key (It should be inversible): "); for(int i=0;i<3;i++)
for(int j=0;j<3;j++) a[i][j]
= sc.nextFloat();
System.out.print("\nEnter a 3 letter string: "); String
    msg = br.readLine();
for(int i=0;i<3;i++)
mes[i][0] = msg.charAt(i)-97;
    }

public static void inverse()
{ float p,q;
float[][] c = a; for(int
i=0;i<3;i++) for(int
j=0;j<3;j++) {
        //a[i][j]=sc.nextFloat();
        if(i==j)
        b[i][j]=1;
        else b[i][j]=0;
    }
    for(int k=0;k<3;k++)
{ for(int i=0;i<3;i++) {
        p = c[i][k];
        q = c[k][k];
        for(int j=0;j<3;j++) { if(i!=k)
        {

```

```

c[i][j] = c[i][j]*q-p*c[k][j];
b[i][j] = b[i][j]*q-p*b[k][j];
    } } }
for(int i=0;i<3;i++)
for(int j=0;j<3;j++)
{ b[i][j] = b[i][j]/c[i][i]; }

System.out.println(""); System.out.println("\nInverse
Matrix is : "); for(int i=0;i<3;i++) {
for(int j=0;j<3;j++)
System.out.print(b[i][j] + " ");
System.out.print("\n"); }
    } }

```

Output:

Enter a 3 letter string: hai

Encrypted string is :fdx

Inverse Matrix is:

0.083333336 0.41666666 -0.33333334

-0.41666666 -0.083333336 0.66666667

0.5833333 -0.083333336 -0.33333334

Decrypted string is: hai

4. Java program for DES algorithm logic

AIM: Write a Java program to implement the DES algorithm logic.

PROGRAM:

```
import java.util.*;
import java.io.BufferedReader; import
java.io.InputStreamReader; import
java.security.spec.KeySpec; import
javax.crypto.Cipher;
import javax.crypto.SecretKey;
import javax.crypto.SecretKeyFactory; import
javax.crypto.spec.DESedeKeySpec; import
sun.misc.BASE64Decoder;
import sun.misc.BASE64Encoder;
public class DES{
private static final String UNICODE_FORMAT = "UTF8";
public static final String DESEDE_ENCRYPTION_SCHEME = "DESEde";
private KeySpec myKeySpec; private SecretKeyFactory mySecretKeyFactory;
private Cipher cipher;
byte[] keyAsBytes;
private String myEncryptionKey; private
String myEncryptionScheme; SecretKey
key;
static BufferedReader br = new BufferedReader(new
InputStreamReader(System.in)); public DES() throws Exception {
// TODO code application logic here myEncryptionKey
= "ThisIsSecretEncryptionKey"; myEncryptionScheme =
DESEDE_ENCRYPTION_SCHEME; keyAsBytes =
myEncryptionKey.getBytes(UNICODE_FORMAT); myKeySpec
```

```

    = new DESedeKeySpec(keyAsBytes);
    mySecretKeyFactory = SecretKeyFactory.getInstance(myEncryptionScheme); cipher
    = Cipher.getInstance(myEncryptionScheme);
    key = mySecretKeyFactory.generateSecret(myKeySpec);

    }
    public String encrypt(String unencryptedString)
        { String encryptedString = null;
    try {
        cipher.init(Cipher.ENCRYPT_MODE, key);
        byte[] plainText = unencryptedString.getBytes(UNICODE_FORMAT); byte[]
        encryptedText = cipher.doFinal(plainText);

            BASE64Encoder base64encoder = new BASE64Encoder(); encryptedString
        = base64encoder.encode(encryptedText); }
        catch (Exception e)
        { e.printStackTrace(); }
        return encryptedString; }
    public String decrypt(String encryptedString)
        { String decryptedText=null;
    try {
        cipher.init(Cipher.DECRYPT_MODE, key);

            BASE64Decoder base64decoder = new BASE64Decoder(); byte[]
        encryptedText = base64decoder.decodeBuffer(encryptedString); byte[]
        plainText = cipher.doFinal(encryptedText); decryptedText=
        bytes2String(plainText); }
        catch (Exception e)
        { e.printStackTrace(); }
        return decryptedText; }

    private static String bytes2String(byte[] bytes)
    { StringBuffer stringBuffer = new StringBuffer();
    for (int i = 0; i < bytes.length;

```

```

i++) { stringBuffer.append((char) bytes[i]); }
return stringBuffer.toString(); }

public static void main(String args []) throws Exception
{ System.out.print("Enter the string: "); DES
    myEncryptor= new DES();
    String stringToEncrypt = br.readLine();
    String encrypted = myEncryptor.encrypt(stringToEncrypt); String
    decrypted = myEncryptor.decrypt(encrypted);
    System.out.println("\nString To Encrypt: " +stringToEncrypt);
    System.out.println("\nEncrypted Value : " +encrypted);
    System.out.println("\nDecrypted Value : " +decrypted); System.out.println("");
}
}

```

OUTPUT:

```

Enter the string: Welcome String
To Encrypt: Welcome
Encrypted Value : BPQMwC0wKvg=
Decrypted Value : Welcome

```

5. Program to implement BlowFish algorithm logic

AIM: Write a C/JAVA program to implement the BlowFish algorithm logic.

PROGRAM:

```
import java.io.*;
import java.io.FileInputStream;
import java.io.FileOutputStream;
import java.security.Key;
import javax.crypto.Cipher;
import javax.crypto.CipherOutputStream;
import javax.crypto.KeyGenerator;
import sun.misc.BASE64Encoder;
public class BlowFish{
    public static void main(String[] args) throws Exception {
        // TODO code application logic here
        KeyGenerator keyGenerator = KeyGenerator.getInstance("Blowfish");
        keyGenerator.init(128);
        Key secretKey = keyGenerator.generateKey();
        Cipher cipherOut = Cipher.getInstance("Blowfish/CFB/NoPadding");
        cipherOut.init(Cipher.ENCRYPT_MODE, secretKey);
        BASE64Encoder encoder = new BASE64Encoder();
        byte iv[] = cipherOut.getIV();
        if (iv != null) {
            System.out.println("Initialization Vector of the Cipher: " + encoder.encode(iv));
        }
        FileInputStream fin = new FileInputStream("inputFile.txt");
        FileOutputStream fout = new FileOutputStream("outputFile.txt");
        CipherOutputStream cout = new CipherOutputStream(fout, cipherOut);
        int input = 0;
        while ((input = fin.read()) != -1)
        { cout.write(input); }
```

```
fin.close(); cout.close();    }}
```

OUTPUT:

Initialization Vector of the Cipher: dl lMXzW97oQ=

Contents of inputFile.txt: Hello World

Contents of outputFile.txt: ùJÖ~ NâI"

6. Program to implement Rijndael algorithm logic

AIM: Write a C/JAVA program to implement the Rijndael algorithm logic.

PROGRAM:

```
import java.security.*;import
javax.crypto.*; import
javax.crypto.spec.*; import
java.io.*;
public class AES {
public static String asHex (byte buff[]) { StringBuffer
strbuf = new StringBuffer(buff.length * 2); int i;
for (i = 0; i < buff.length; i++) { if
(((int) buff[i] & 0xff) < 0x10)
strbuf.append("0");
strbuf.append(Long.toString((int) buff[i] & 0xff, 16)); } return
strbuf.toString(); }
public static void main(String[] args) throws Exception
{ String message="AES still rocks!!";
// Get the KeyGenerator
KeyGenerator kgen = KeyGenerator.getInstance("AES");
kgen.init(128); // 192 and 256 bits may not be available
// Generate the secret key specs. SecretKey
skey=kgen.generateKey();byte[] raw =
skey.getEncoded();
SecretKeySpec skeySpec = new SecretKeySpec(raw, "AES");
// Instantiate the cipher
Cipher cipher = Cipher.getInstance("AES");
cipher.init(Cipher.ENCRYPT_MODE, skeySpec);
byte[] encrypted = cipher.doFinal((args.length == 0 ? message :
```

```
args[0]).getBytes()); System.out.println("encrypted string: " +  
asHex(encrypted)); cipher.init(Cipher.DECRYPT_MODE, skeySpec); byte[]  
original = cipher.doFinal(encrypted);  
String originalString = new String(original);  
System.out.println("Original string: " + originalString + " " + asHex(original));  
}  
}
```

OUTPUT:

Input your message: Hello KGR CET

Encrypted text: 3000&&(&*4r4*

Decrypted text: Hello KGR CET

7. Encrypt a string using BlowFish algorithm

AIM: Using Java Cryptography, encrypt the text "Hello world" using BlowFish. Create your own key using Java keytool.

PROGRAM:

```
import javax.crypto.Cipher; import
javax.crypto.KeyGenerator; import
javax.crypto.SecretKey; import
javax.swing.JOptionPane; public
class BlowFishCipher {
public static void main(String[] args) throws Exception {
    // create a key generator based upon the Blowfish cipher
    KeyGenerator keygenerator = KeyGenerator.getInstance("Blowfish");
    // create a key
    // create a cipher based upon Blowfish Cipher cipher
    = Cipher.getInstance("Blowfish");
    // initialise cipher to with secret key
    cipher.init(Cipher.ENCRYPT_MODE, secretkey);
    // get the text to encrypt
    String inputText = JOptionPane.showInputDialog("Input your message: "); //
    encrypt message
    byte[] encrypted = cipher.doFinal(inputText.getBytes());
    // re-initialise the cipher to be in decrypt mode
    cipher.init(Cipher.DECRYPT_MODE, secretkey);
    // decrypt message
    byte[] decrypted = cipher.doFinal(encrypted);
    // and display the results
```

```
JOptionPane.showMessageDialog(JOptionPane.getRootFrame(), "\nEncrypted  
text: " + new String(encrypted) + "\n" + "\nDecrypted text: " + new  
String(decrypted));  
System.exit(0);  
}}
```

OUTPUT:

Input your message: Hello world

Encrypted text: 3ooo&&(&*4r4*

Decrypted text: Hello world

8. RSA Algorithm

AIM: Write a Java program to implement RSA Algorithm.

PROGRAM:

```
import java.io.BufferedReader; import
java.io.InputStreamReader; import
java.math.*;
import java.util.Random;
import java.util.Scanner;
public class RSA{
static Scanner sc = new Scanner(System.in); public
static void main(String[] args) {
    // TODO code application logic here
    System.out.print("Enter a Prime number: ");
    BigInteger p = sc.nextBigInteger(); // Here's one prime number..
    System.out.print("Enter another prime number: "); BigInteger q =
    sc.nextBigInteger(); // ..and another.
    BigInteger n = p.multiply(q);
    BigInteger n2 = p.subtract(BigInteger.ONE).multiply(q.subtract(BigInteger.ONE)); BigInteger e
    = generateE(n2);
    BigInteger d = e.modInverse(n2); // Here's the multiplicative inverse

    System.out.println("Encryption keys are: " + e + ", " + n);
    System.out.println("Decryption keys are: " + d + ", " + n);
    }
    public static BigInteger generateE(BigInteger f) { int y,
    int GCD;
    BigInteger e;
    BigInteger gcd;
        Random x = new Random();
    do {
```

```
        y = x.nextInt(fiofn.intValue()-1);
        String z = Integer.toString(y);
        e = new BigInteger(z);
gcd = fiofn.gcd(e);
intGCD = gcd.intValue();
    }
while(y <= 2 || intGCD != 1);
return e;
    }
}
```

OUTPUT:

Enter a Prime number: 5

Enter another prime number: 11

Encryption keys are: 33, 55

Decryption keys are: 17, 55

9. Diffie-Hellman

AIM: Implement the Diffie-Hellman Key Exchange mechanism using HTML and JavaScript. Consider the end user as one of the parties (Alice) and the JavaScript application as other party (bob).

PROGRAM:

```
import java.math.BigInteger; import
java.security.KeyFactory; import
java.security.KeyPair;
import java.security.KeyPairGenerator;
import java.security.SecureRandom;
import javax.crypto.spec.DHParameterSpec;
import javax.crypto.spec.DHPublicKeySpec;
public class DiffieHellman{
    public final static int pValue = 47;
    public final static int gValue = 71;
    public final static int XaValue = 9;
    public final static int XbValue = 14;
    public static void main(String[] args) throws Exception
        { // TODO code application logic here
        BigInteger p = new BigInteger(Integer.toString(pValue));
        BigInteger g = new BigInteger(Integer.toString(gValue));
        BigInteger Xa = new BigInteger(Integer.toString(XaValue));
        BigInteger Xb = new BigInteger(Integer.toString(XbValue));
        createKey(); int bitLength = 512; // 512 bits
        SecureRandom rnd = new SecureRandom();
        p = BigInteger.probablePrime(bitLength, rnd); g =
        BigInteger.probablePrime(bitLength, rnd);
```

```

createSpecificKey(p, g);
    }
    public static void createKey() throws Exception {
        KeyPairGenerator kpg = KeyPairGenerator.getInstance("DiffieHellman"); kpg.initialize(512);
        KeyPair kp = kpg.generateKeyPair();
        KeyFactory kfactory = KeyFactory.getInstance("DiffieHellman"); DHPrivateKeySpec spec =
        (DHPrivateKeySpec) kfactory.getKeySpec(kp.getPrivate(), DHPrivateKeySpec.class);
        System.out.println("Public key is: " + kspect);
    }
    public static void createSpecificKey(BigInteger p, BigInteger g) throws Exception
    { KeyPairGenerator kpg = KeyPairGenerator.getInstance("DiffieHellman");
        DHParameterSpec param = new DHParameterSpec(p, g); kpg.initialize(param);
        KeyPair kp = kpg.generateKeyPair();
        KeyFactory kfactory = KeyFactory.getInstance("DiffieHellman"); DHPrivateKeySpec spec =
        (DHPrivateKeySpec) kfactory.getKeySpec(kp.getPrivate(), DHPrivateKeySpec.class);
        System.out.println("\nPublic key is : " + kspect);
    }
}

```

OUTPUT:

Public key is: javax.crypto.spec.DHPrivateKeySpec@5afd29

Public key is: javax.crypto.spec.DHPrivateKeySpec@9971ad

10. SHA-1

AIM: Calculate the message digest of a text using the SHA-1 algorithm in JAVA.

PROGRAM:

```
import java.security.*; public
class SHA1 {
public static void main(String[] a) { try
{
MessageDigest md = MessageDigest.getInstance("SHA1");
System.out.println("Message digest object info: ");
System.out.println(" Algorithm = " +md.getAlgorithm());
System.out.println(" Provider = " +md.getProvider());
System.out.println(" ToString = " +md.toString());

        String input = "";
md.update(input.getBytes());
byte[] output = md.digest();
System.out.println();
System.out.println("SHA1(\""+input+"\") = " +bytesToHex(output));

input = "abc";
md.update(input.getBytes());
output = md.digest();
System.out.println();
System.out.println("SHA1(\""+input+"\") = " +bytesToHex(output));

input = "abcdefghijklmnopqrstuvwxyz";
md.update(input.getBytes());
output = md.digest();
System.out.println();
System.out.println("SHA1(\""+input+"\") = " +bytesToHex(output)); System.out.println(""); }
catch (Exception e) {
```

```
System.out.println("Exception: " +e);
```

```
}
```

```
}
```

```
public static String bytesToHex(byte[] b) {
```

```
    char hexDigit[] = {'0', '1', '2', '3', '4', '5', '6', '7', '8', '9', 'A', 'B', 'C', 'D', 'E', 'F'};
```

```
    StringBuffer buf = new StringBuffer(); for
```

```
(int j=0; j<b.length;j++)
```

```
{ buf.append(hexDigit[(b[j] >> 4) & 0x0f]);
```

```
buf.append(hexDigit[b[j] & 0x0f]); }
```

```
return buf.toString(); }
```

```
}
```

OUTPUT:

Message digest object info:

Algorithm = SHA1

Provider = SUN version 1.6

ToString = SHA1 Message Digest from SUN, <initialized> SHA1("") =

DA39A3EE5E6B4B0D3255BFEF95601890AFD80709 SHA1("abc") =

A9993E364706816ABA3E25717850C26C9CD0D89D

SHA1("abcdefghijklmnopqrstuvwxyz")=32D10C7B8CF96570CA04CE37F2A19D8424 0D3A89

11. Message Digest Algorithm5 (MD5)

AIM: Calculate the message digest of a text using the SHA-1 algorithm in JAVA.

PROGRAM:

```
import java.security.*; public
class MD5 {
    public static void main(String[] a) {
        // TODO code application logic here
        try {
            MessageDigest md = MessageDigest.getInstance("MD5");
            System.out.println("Message digest object info: ");
            System.out.println(" Algorithm = " +md.getAlgorithm());
            System.out.println(" Provider = " +md.getProvider());
            System.out.println(" ToString = " +md.toString());

            String input = "";
            md.update(input.getBytes());
            byte[] output = md.digest();
            System.out.println();
            System.out.println("MD5(\""+input+"\") = " +bytesToHex(output));

            input = "abc";
            md.update(input.getBytes());
            output = md.digest();
            System.out.println();
            System.out.println("MD5(\""+input+"\") = " +bytesToHex(output));

            input = "abcdefghijklmnopqrstuvwxyz";
            md.update(input.getBytes());
            output = md.digest();
            System.out.println();
            System.out.println("MD5(\""+input+"\") = "
            +bytesToHex(output)); System.out.println("");
        }
    }
}
```

```

catch (Exception e)
{ System.out.println("Exception: " +e); }
}

public static String bytesToHex(byte[] b) {
    char hexDigit[] = {'0', '1', '2', '3', '4', '5', '6', '7', '8', '9', 'A', 'B', 'C', 'D', 'E', 'F'};
    StringBuffer buf = new StringBuffer(); for
    (int j=0; j<b.length;j++)
    { buf.append(hexDigit[(b[j] >> 4) & 0x0f]);
    buf.append(hexDigit[b[j] & 0x0f]); }
    return buf.toString(); } }

```

OUTPUT:

Message digest object info:

Algorithm = MD5

Provider = SUN version 1.6

ToString = MD5 Message Digest from SUN, <initialized> MD5("") =

D41D8CD98F00B204E9800998ECF8427E MD5("abc") =

900150983CD24FB0D6963F7D28E17F72 MD5("abcdefghijklmnopqrstuvwxyz")

= C3FCD3D76192E4007DFB496CCA67E13B