Dominik Ciesiołkiewicz 44289 Sprawozdanie Lab 10 - Właściwości toru transmisyjnego

W poniższym zadaniu zastosowałem szum biały, na którego algorytm podany był przez Pana mgr. inż. Wernika w opisie do poniższego laboratorium. Ważniejsze części kodu dotyczące tego zadania (a nie poprzedniego) pozwoliłem sobie zaznaczyć niebieską czcionką, dla ułatwienia sprawdzania. Wykresy znajdują się na końcu sprawozdania.

Poziomy szumów:

Małe (<0.30) dla alfa>0.3
Średnie (0.30-0.50) dla 0.1<alfa<0.3
Duże (>0.50) dla alfa<0.1

Kod:

```
#include <iostream>
#include <fstream>
#include <complex>
#include <bitset>
#include <vector>
#include <cstdlib>
#include <ctime>

using namespace std;

double pi = 3.14159265359;

int lengthOfString(string str)
{
   return str.length();
}

string S2BS(string in, bool choice)  //String To Binary Stream
{
   string out = "";

   int n = in.length();
   string bity = "";

   if (choice == 1)//LittleEndian
   {
      for (int i = 0; i < n; i++)
      {
         int wartosc = int(in[i]);
         bity = "";
```

```
        while (wartosc > 0)
        {
            if (wartosc % 2)
            {
                bity += '1';
            }
            else
            {
                bity += '0';
            }
            wartosc = wartosc / 2;
        }
        out += bity;
    }
    reverse(out.begin(), out.end());
    //cout << out << endl;
    return out;
  }
  else {//BigEndian
    for (int i = 0; i < n; i++)
    {
        int wartosc = int(in[i]);
        bity = "";

        while (wartosc > 0)
        {
            if (wartosc % 2)
            {
                bity += '1';
            }
            else
            {
                bity += '0';
            }
            wartosc = wartosc / 2;
        }
        reverse(bity.begin(), bity.end());
        out += bity;
    }
    //cout << out << endl;
    return out;
  }
}

string BS2S(string charset)
{
  stringstream strumien(charset);
```

```
    string result;

    while (strumien.good())
    {
        bitset<7> bity;

        strumien >> bity;
        char znak = char(bity.to_ulong());

        result += znak;
    }

    return result;
}

int* Hamming(int* d)
{
    int G[7][4] = { {1,1,0,1},{1,0,1,1},{1,0,0,0},{0,1,1,1},{0,1,0,0},{0,0,1,0},{0,0,0,1} };
    int* K = new int[7];

    for (int i = 0; i < 7; i++)
    {
        K[i] = 0;
        for (int j = 0; j < 4; j++)
        {
            //cout << G[i][j];
            //cout<<d[j]<<endl;
            K[i] += G[i][j] * (d[j]);
        }
        //cout << endl;
    }

    /*cout << "K:" << endl;
    for (int i = 0; i < 7; i++)
    {
        cout << K[i] << endl;
    }
    cout << endl;

    cout << "K modulo 2:" << endl;*/
    for (int i = 0; i < 7; i++)
    {
        K[i] = K[i] % 2;
        //cout << K[i] << endl;
    }
    //cout << endl;

    return K;
```

```
}

int* HammingM(int* d)
{
   int* KD = new int[7];

   KD[2] = d[0];
   KD[4] = d[1];
   KD[5] = d[2];
   KD[6] = d[3];

   if (d[0] != 0 && d[0] != 1)
      KD[2] = 0;
   if (d[1] != 0 && d[1] != 1)
      KD[4] = 0;
   if (d[2] != 0 && d[2] != 1)
      KD[5] = 0;
   if (d[3] != 0 && d[3] != 1)
      KD[6] = 0;

   KD[0] = KD[2] ^ KD[4] ^ KD[6];
   KD[1] = KD[2] ^ KD[5] ^ KD[6];
   KD[3] = KD[4] ^ KD[5] ^ KD[6];

   return KD;
}

int* HammingSECDEC(string d)
{
   int G[7][4] = { {1,1,0,1},{1,0,1,1},{1,0,0,0},{0,1,1,1},{0,1,0,0},{0,0,1,0},{0,0,0,1} };
   int* K = new int[8];

   for (int i = 0; i < 7; i++)
   {
      K[i] = 0;
      for (int j = 0; j < 4; j++)
      {
         K[i] += G[i][j] * (d[j] - '0');
      }
   }

   /*cout << "K:" << endl;
   for (int i = 0; i < 7; i++)
   {
      cout << K[i] << endl;
   }
   cout << endl;
```

```
    cout << "K modulo 2:" << endl;*/
    for (int i = 0; i < 7; i++)
    {
        K[i] = K[i] % 2;
        //cout << K[i] << endl;
    }
    //cout << endl;

    //Dla SECDEC:
    //cout << "Ze sprawdzajacym bitem: " << endl;
    int err = 0;
    for (int i = 0; i < 7; i++)
    {
        err += K[i];
    }
    err = err % 2;
    K[7] = err;

    /*for (int i = 0; i < 8; i++)
    {
        cout << K[i] << endl;
    }
    cout << endl;*/

    return K;
}

int* DecHamming(int* K)
{
    int H[3][7] = { {1,0,1,0,1,0,1},{0,1,1,0,0,1,1},{0,0,0,1,1,1,1} };
    int* KD = new int[7];

    for (int i = 0; i < 3; i++)
    {
        KD[i] = 0;
        for (int j = 0; j < 7; j++)
        {
            KD[i] += H[i][j] * K[j];
        }
    }

    for (int i = 0; i < 3; i++)
    {
        KD[i] = KD[i] % 2;
    }

    return KD;
}
```

```
int* DecHammingM(int* K)
{
   int* KD = new int[4];

   KD[0] = K[2];
   KD[1] = K[4];
   KD[2] = K[5];
   KD[3] = K[6];

   return KD;
}

int* DecHammingSECDEC(int* K)
{
   int H[3][7] = { {1,0,1,0,1,0,1},{0,1,1,0,0,1,1},{0,0,0,1,1,1,1} };
   int* KD = new int[7];

   cout << "Sprawdzanie p4:" << endl;
   int err = 0;
   for (int i = 0; i < 7; i++)
   {
      err += K[i];
   }
   err = err % 2;

   if (err != K[7])
   {
      cout << "P4 nie jest zgodne. Mamy 50% szans na powodzenie naprawy." << endl << endl;
   }
   else
   {
      cout << "P4 jest zgodne" << endl << endl;
   }

   int p1 = (K[0] + K[2] + K[4] + K[6]) % 2;
   int p2 = (K[1] + K[2] + K[5] + K[6]) % 2;
   int p3 = (K[3] + K[4] + K[5] + K[6]) % 2;

   int n = p1 * 1 + p2 * 2 + p3 * 4 - 1;

   cout << "Poprawiony kod odebrany:" << endl;
   if (K[n] == 0)
   {
      K[n] = 1;
   }
   else
   {
```

```
        K[n] = 0;
    }

    for (int i = 0; i < 8; i++)
    {
        cout << K[i] << endl;
    }

    cout << endl << "Sprawdzanie p4 - ponowne:" << endl;
    n = 0;
    for (int i = 0; i < 7; i++)
    {
        n += K[i];
    }
    n = n % 2;

    if (n != K[7])
    {
        cout << "P4 nie jest zgodne. Sa co najmniej 2 bledne bity. Odrzucamy pakiet." << endl << endl;
        return NULL;
    }
    else
    {
        cout << "P4 jest zgodne, odkodowujemy:" << endl << endl;

        cout << "Informacja odkodowana:" << endl;
        cout << K[2] << endl;
        cout << K[4] << endl;
        cout << K[5] << endl;
        cout << K[6] << endl;
    }

    return K;
}

int* BitNegation(int* K, int NoBit)
{
    if (K[NoBit] == 0)
        K[NoBit] = 1;
    else
        K[NoBit] = 0;
    return K;
}

double ASKF(int m, double t)
{
    double A1 = 0;
    double A2 = 2.0;
```

```
   double f = 2.0;
   double phi = 0.0;

   if (m == 0)
      return (A1 * sin(2 * pi * t * f + phi));
   else
      return (A2 * sin(2 * pi * t * f + phi));
}

double FSKF(int m, double t)
{
   double A = 1;
   double f0 = 1.0;
   double f1 = 2.0;
   double phi = 1.0;

   if (m == 0)
      return (A * sin(2 * pi * t * f0 + phi));
   else
      return (A * sin(2 * pi * t * f1 + phi));
}

double PSKF(int m, double t)
{
   double A = 1;
   double f = 2.0;
   double phi0 = 0.0;
   double phi1 = pi;

   if (m == 0)
      return A * sin(2 * pi * t * f + phi0);
   else
      return A * sin(2 * pi * t * f + phi1);
}

double ASKDx(double v, double SinE)
{
   return v * SinE;
}

double ASKDp(double vX, double del)
{
   return del * vX;
}

double ASKDm(double vP, double h)
{
   if (vP > h)
```

```
        return 1;
    else
        return 0;
}

double* noise(double* sig, double* ret, int len)
{
    const static int q = 15;
    const static float c1 = (1 << q) - 1;
    const static float c2 = ((int)(c1 / 3)) + 1;
    const static float c3 = 1.f / c1;

    float random = 0.f;

    float noisef = 0.f;
    float alfa = 0.25;
    int nn = 0, NN = len * 40;

    for (int i = 0; i < len * 40; i++)
    {
        random = ((float)rand() / (float)(RAND_MAX + 1));
        noisef = (2.f * ((random * c2) + (random * c2) + (random * c2)) - 3.f * (c2 - 1.f)) * c3;
        ret[i] = (sig[i] * alfa) + (noisef * (1.0 - alfa));
        //cout << sig[i] << endl;
        nn++;
        if (nn >= NN)
        {
            nn = 0;
        }
    }

    return ret;
}

int main()
{
    double Tb = 0.1; //[s]
    int fs = 10000; //[Hz]

    //WCZYTYWANIE INFORMACJI
    cout << "Zdanie zakodowane: ALAMAKOTA" << endl;

    string str = S2BS("ALAMAKOTA", 0);
    int n = lengthOfString(str);
    cout << "Ilosc bitow transmisji: " << n << endl << endl;

    int* tab = new int[n];
```

```
for (int i = 0; i < n; i++)
{
   if (str[i] == 48)
      tab[i] = 0;
   else
      tab[i] = 1;
}

ofstream saveData("Dane.txt");

cout << "Informacja:" << endl;
for (int i = 0; i < n; i++)
{
   cout << tab[i];
}
cout << endl << endl;
saveData << str << endl;

saveData.close();

vector<int> vectorASKD;
vector<int> vectorFSKD;
vector<int> vectorPSKD;
vector<int> dASK;
vector<int> dFSK;
vector<int> dPSK;
vector<int> dASKAMP;
vector<int> dFSKAMP;
vector<int> dPSKAMP;

bool SECDEC = 0;// 0-zwykly kod Hamminga; 1-SECDEC

//KODOWANIE KODEM HAMMINGA
int* HammingF;
int* HammingZ;
vector<int> vector;


for (int i = 0; i < n; i += 4)
{
   HammingF = HammingM(&tab[i]);

   for (int i = 0; i < 7; i++)
      vector.push_back(HammingF[i]);
}

cout << "Dane zakodowane:" << endl;
for (int i = 0; i < vector.size(); i++)
```

```
{
   cout << vector[i];
}
cout << endl << endl;

//MODULACJA
ofstream ASKf("ASK.txt");
ofstream PSKf("PSK.txt");
ofstream FSKf("FSK.txt");
ofstream time("time.txt");

double diff = 0.025;//bo 1/40

double* ASK = new double[vector.size() * 40];
double* PSK = new double[vector.size() * 40];
double* FSK = new double[vector.size() * 40];

int* Sinus1 = new int[vector.size() * 40];
int* Sinus2 = new int[vector.size() * 40];
int* Sinus3 = new int[vector.size() * 40];
int* Sinus4 = new int[vector.size() * 40];

for (int i = 0; i < vector.size() * 40; i++)
{
   ASK[i] = ASKF(vector[int(i * diff)], i * diff);
   PSK[i] = PSKF(vector[int(i * diff)], i * diff);
   FSK[i] = FSKF(vector[int(i * diff)], i * diff);
   ASKf << ASKF(vector[int(i * diff)], i * diff) << endl;
   PSKf << PSKF(vector[int(i * diff)], i * diff) << endl;
   FSKf << FSKF(vector[int(i * diff)], i * diff) << endl;
   //cout << ASK[i] << endl;
   time << i << endl;

   Sinus1[i] = ASKF(1, i * diff);
   Sinus2[i] = PSKF(1, i * diff);
   Sinus3[i] = FSKF(0, i * diff);
   Sinus4[i] = FSKF(1, i * diff);
}

//SZUM
ofstream ASKszum("ASK_Noise.txt");
ofstream PSKszum("PSK_Noise.txt");
ofstream FSKszum("FSK_Noise.txt");

double* ASKSz = new double[vector.size() * 40];
double* PSKSz = new double[vector.size() * 40];
double* FSKSz = new double[vector.size() * 40];
```

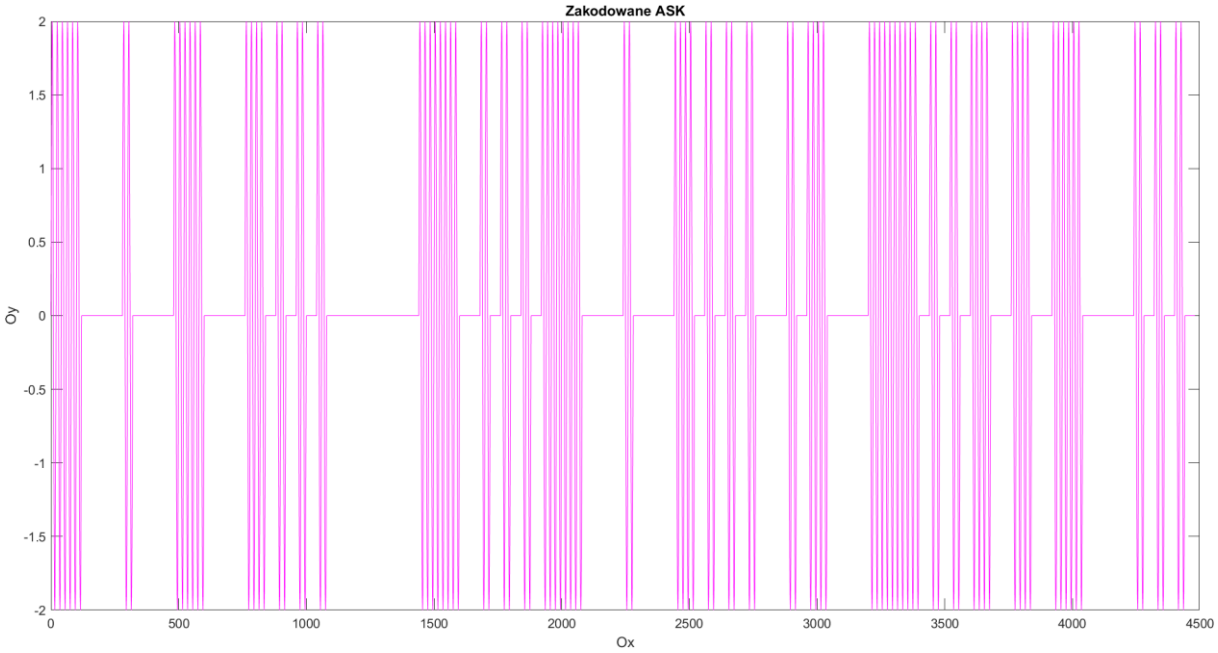
```
ASK = noise(ASK, ASKSz, vector.size());
PSK = noise(PSK, PSKSz, vector.size());
FSK = noise(FSK, FSKSz, vector.size());

for (int i = 0; i < vector.size() * 40; i++)
{
   ASKszum << ASK[i] << endl;
   PSKszum << PSK[i] << endl;
   FSKszum << FSK[i] << endl;
}

ASKszum.close();
PSKszum.close();
FSKszum.close();

//DEMODULACJA
double tempASK = 0;
double tempFSK = 0;
double tempPSK1 = 0;
double tempPSK2 = 0;
double tempPSK3 = 0;

for (int i = 0; i < vector.size() * 40; i++)
{
   if (i >= 1)
   {
      tempASK = ASKDp(ASKDx(ASK[i], Sinus1[i]), diff) + ASKDp(ASKDx(ASK[i - 1], Sinus1[i - 1]), diff);
      tempFSK = ASKDp(ASKDx(FSK[i], Sinus2[i]), diff) + ASKDp(ASKDx(FSK[i - 1], Sinus2[i - 1]), diff);
      tempPSK1 = ASKDp(ASKDx(PSK[i], Sinus3[i]), diff) + ASKDp(ASKDx(PSK[i - 1], Sinus3[i - 1]), diff);
      tempPSK2 = ASKDp(ASKDx(PSK[i], Sinus4[i]), diff) + ASKDp(ASKDx(PSK[i - 1], Sinus4[i - 1]), diff);
      tempPSK3 = tempPSK2 - tempPSK1;
   }
   else
   {
      tempASK = ASKDp(ASKDx(ASK[i], Sinus1[i]), diff);
      tempFSK = ASKDp(ASKDx(FSK[i], Sinus2[i]), diff);
      tempPSK3 = (ASKDp(ASKDx(PSK[i], Sinus4[i]), diff) - ASKDp(ASKDx(PSK[i], Sinus3[i]), diff));
   }
   dASK.push_back(ASKDm(tempASK, 0));
   dFSK.push_back(ASKDm(tempFSK, 0));
   dPSK.push_back(ASKDm(tempASK, 0));
}

for (int i = 5; i < dASK.size(); i += 40)
{
   dASKAMP.push_back(dASK[i]);
   dFSKAMP.push_back(dFSK[i]);
   dPSKAMP.push_back(dPSK[i]);
```

```
}

cout << "Demodulacja ASK:" << endl;
for (int i = 0; i < dASKAMP.size(); i++)
{
   cout << dASKAMP[i];
}
cout << endl << endl;

cout << "Demodulacja FSK:" << endl;
for (int i = 0; i < dFSKAMP.size(); i++)
{
   cout << dFSKAMP[i];
}
cout << endl << endl;

cout << "Demodulacja PSK:" << endl;
for (int i = 0; i < dPSKAMP.size(); i++)
{
   cout << dPSKAMP[i];
}
cout << endl;


//DEKODOWANIE
//DEKODOWANIE ASK
for (int i = 0; i < dASKAMP.size(); i += 7)
{
   HammingZ = DecHammingM(&dASKAMP[i]);
   for (int i = 0; i < 4; i++)
      vectorASKD.push_back(HammingZ[i]);
}

cout << endl;
cout << "Dane zdekodowane ASK:" << endl;
for (int i = 0; i < vectorASKD.size(); i++)
{
   cout << vectorASKD[i];
}
cout << endl;

//DEKODOWANIE FSK
for (int i = 0; i < dFSKAMP.size(); i += 7)
{
   HammingZ = DecHammingM(&dFSKAMP[i]);
   for (int i = 0; i < 4; i++)
      vectorFSKD.push_back(HammingZ[i]);
}
```

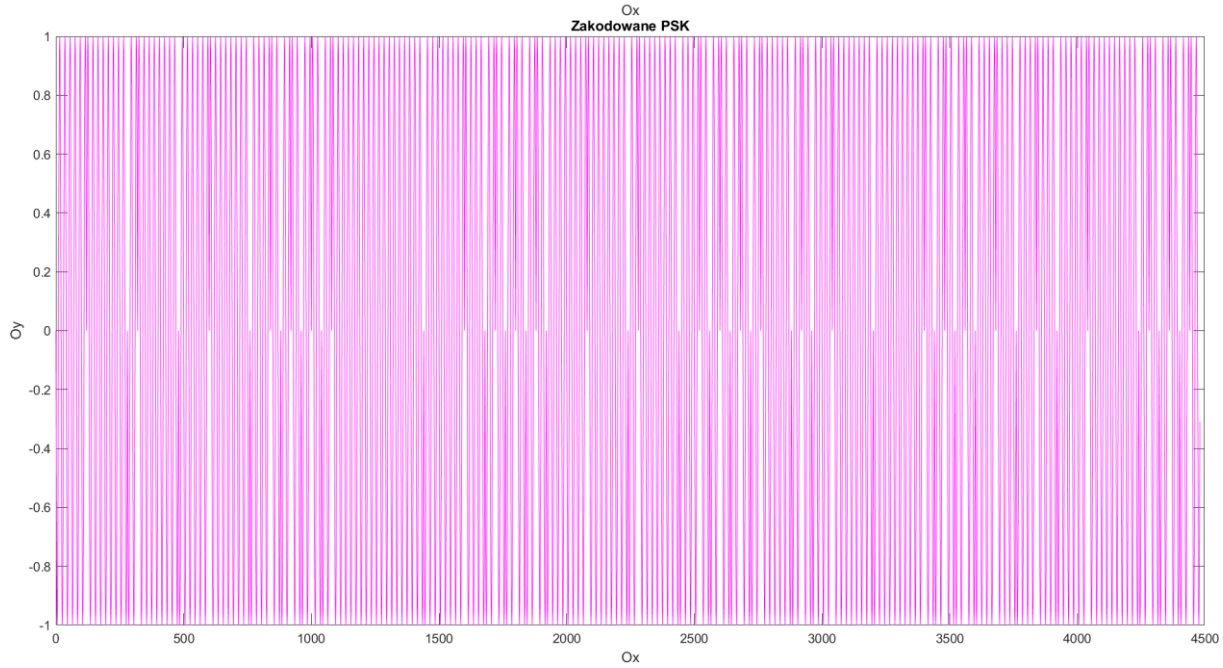
```
cout << endl;
cout << "Dane zdekodowane FSK:" << endl;
for (int i = 0; i < vectorFSKD.size(); i++)
{
   cout << vectorFSKD[i];
}
cout << endl << endl;

//DEKODOWANIE PSK
for (int i = 0; i < dPSKAMP.size(); i += 7)
{
   HammingZ = DecHammingM(&dPSKAMP[i]);
   for (int i = 0; i < 4; i++)
      vectorPSKD.push_back(HammingZ[i]);
}

cout << "Dane zdekodowane PSK:" << endl;
for (int i = 0; i < vectorPSKD.size(); i++)
{
   cout << vectorPSKD[i];
}
cout << endl << endl;

//LICZENIE WSKAŹNIKA BER
double BER = 0;
cout << "Wskaznik BER dla ASK: ";
for (int i = 0; i < n; i++)
{
   if (tab[i] != vectorASKD[i])
      BER++;
}
BER = BER / n;
cout << BER << endl << endl;

//BER = 0;
//cout << "Wskaznik BER dla PSK: ";
//for (int i = 0; i < n; i++)
//{
//    if (tab[i] != vectorPSKD[i])
//        BER++;
//}
//BER = BER / n;
//cout << BER << endl << endl;

//DANE BINARNE NA ZDANIE:
//string decASK;
//string decFSK;
```

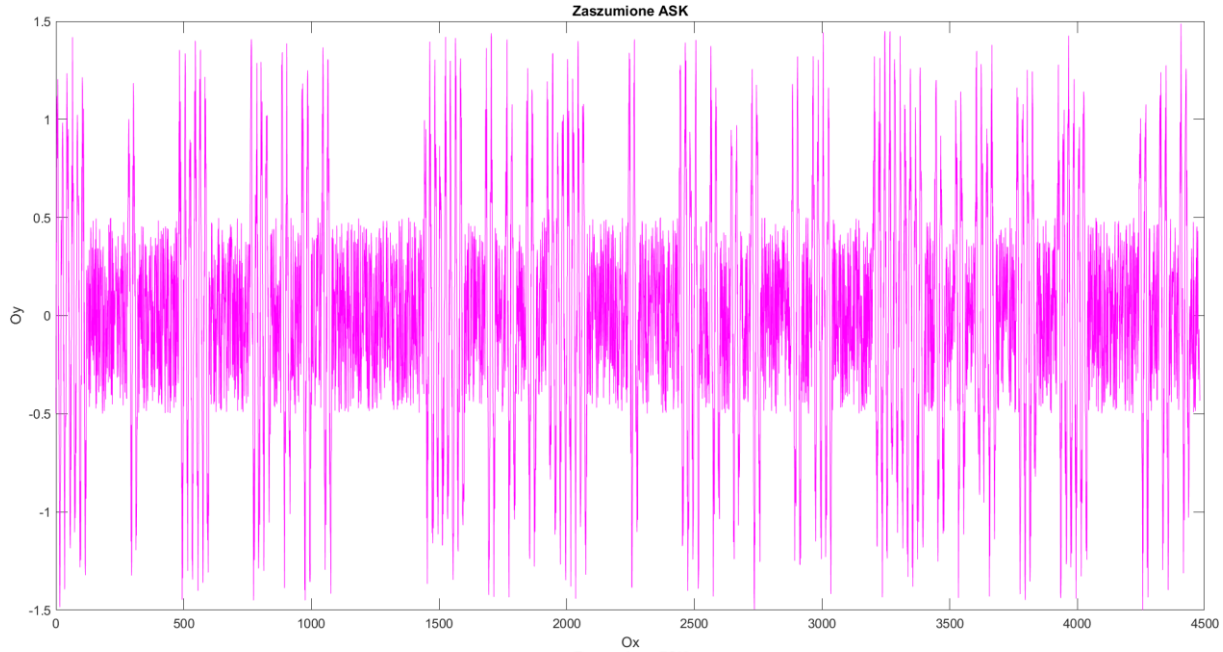
```
    //string decPSK;

    //for (int i = 0; i < vectorASKD.size(); i++)
    //{
    //    decASK += tab[i] + '0';
    //    decFSK += tab[i] + '0';
    //    decPSK += tab[i] + '0';
    //}

    //cout << "Zdanie odtworzone z ASK: " << BS2S(decASK) << endl;
    //cout << "Zdanie odtworzone z FSK: " << BS2S(decFSK) << endl;
    //cout << "Zdanie odtworzone z PSK: " << BS2S(decPSK) << endl;

    //Poziomy szumów:
    //Małe (<0.30) dla alfa>0.3
    //Średnie(0.30-0.50) dla 0.1<alfa<0.3
    //Duże(>0.50) dla alfa<0.1


    ASKf.close();
    PSKf.close();
    FSKf.close();
    time.close();
    return 1;
}
```

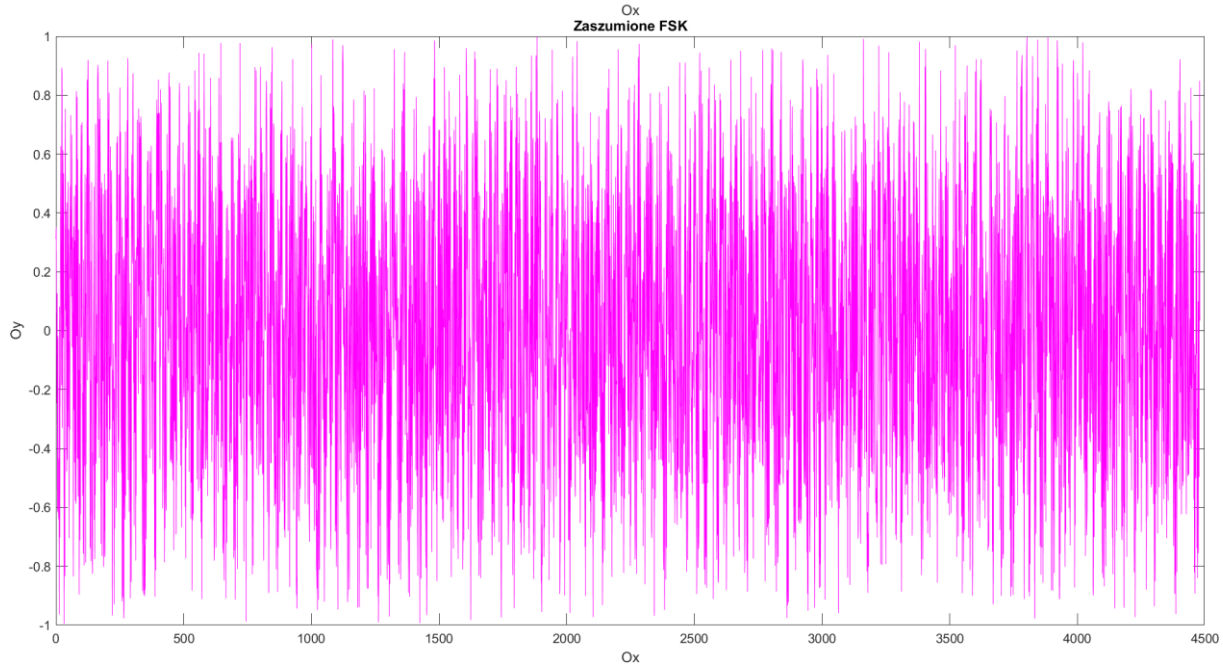
Wykresy:

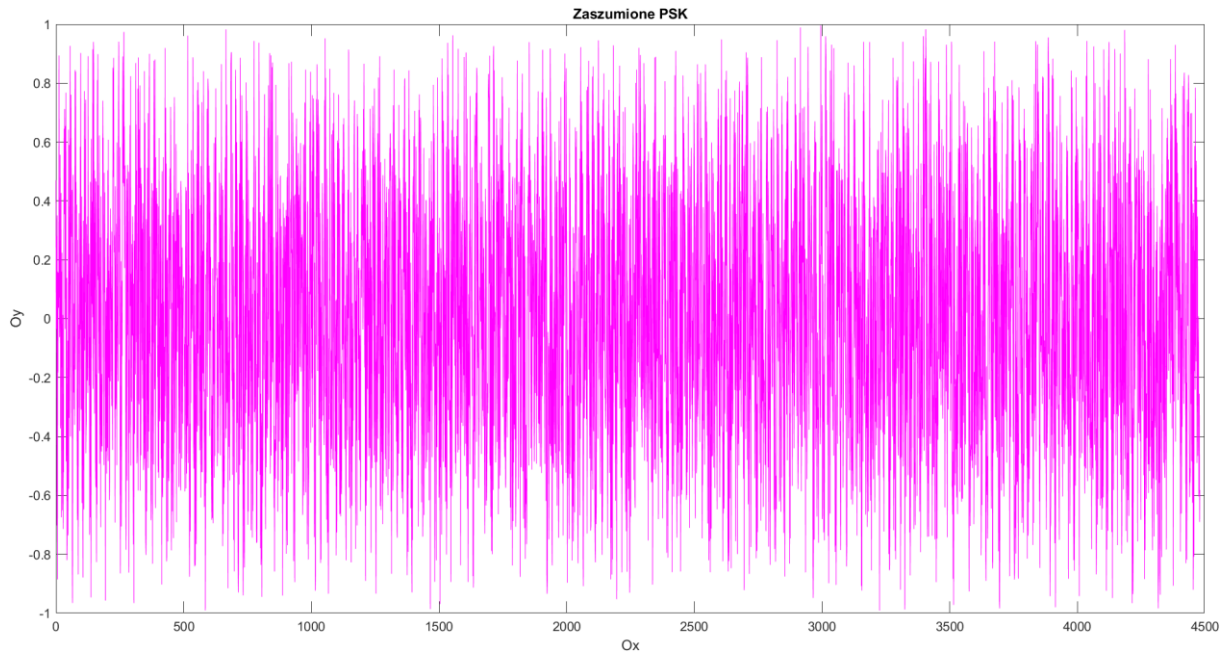



Zakodowane FSK
Oy
Ox
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
500
1000
1500
2000
2500
3000
3500
4000
4500


Zakodowane PSK
Oy
Ox
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
500
1000
1500
2000
2500
3000
3500
4000
4500


Zaszumione ASK
Oy
Ox
1.5
1
0.5
0
-0.5
-1
-1.5
0
500
1000
1500
2000
2500
3000
3500
4000
4500


Zaszumione FSK
Oy
Ox
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
500
1000
1500
2000
2500
3000
3500
4000
4500


Zaszumione PSK
Oy
Ox
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
500
1000
1500
2000
2500
3000
3500
4000
4500