EXPERIMENT NO -4
Entropy and Information theory

AIM:- Find entropy and information rate of the source using SCILAB code.

Theory:-

Entropy:-

- The "Entropy" is defined as the average information per message. It is denoted by H and its units are bits/messages.
- The entropy must be as high as possible in order to ensure maximum transfer of information. We will prove that the entropy depends only on the probabilities of the symbols in the alphabet of the source.

$$H=I1*p1+I2*p2+I3*p3+I4*p4$$

Information Rate (R): -

If the source of the messages generates number of messages per second then the information rate is given as,

$$R=rx\ H$$

Where, r= Number of messages/secs, and H= Average information/message.

Units of information rate:

R =[r(messages/sec) *H(information /message)]

R = Average information per second expressed in bits/sec.

Problems:

Q1). An analog signal is bandlimited to 4 kHz. It is sampled at the Nyquist rate and the samples are quantized into 4 levels. The quantization levels Q1, Q2, Q3 and Q4 are independent messages and have the probabilities P1 = P2 =1/8 and P3 = P4= 3/8. Find entropy and the information rate of the source .

Code:

```
fm=4000;      //modulating frequency
r=2*fm;
disp(r);      //Message rate
p1=1/8;       //probability
p2=1/8;       //probability
p3=3/8;       //probability
p4=3/8;       //probability
I1=log2(1/p1);
//Information I2=log2(1/p2);
I3=log2(1/p3);
I4=log2(1/p4);
disp(I1);
disp(I2);
disp(I3);
disp(I4);
H=I1*p1+I2*p2+I3*p3+I4*p4;
disp(H);      //Entropy
R=r*H;
disp(R);
```

Output:

```
8000.
3.
3.
1.4150375
1.4150375
1.8112781
14490.225
```

Q2). A source consists of 4 letters A, B, C and D for transmission.each letter is coded into sequence of two binary pulses A is represented by 00,B by 01,C by 10 and D by 11. The probability of occurrence of each letter is p(A) =1/5, p(B)=1/4, p(C)=1/4 and p(D) =3/10. Determine the entropy of the source and average rate of transmission of information.

Code:

```
fm=2000;      //modulating frequency
r=2*fm;
disp(r);      //Message rate
pA=1/5;       //probability
pB=1/4;       //probability
pC=1/4;       //probability
pD=3/10;              //probability
I1=log2(1/pA);
//Information I2=log2(1/pB);
I3=log2(1/pC);
I4=log2(1/pD);
disp(I1);
disp(I2);
disp(I3);
disp(I4);
H=I1*pA+I2*pB+I3*pC+I4*pD
; disp(H);      //Entropy
R=r*H;
disp(R);
```

Output:

```
4000.
2.3219281
2.
2.
1.7369656
1.9854753
7941.9012
```

Q3). message source generates one of four messages randomly every microsecond. The probabilities of these messages are 0.4, 0.3, 0.2 and 0.1. Each emitted message is independent of other messages in the sequence :

1) what is entropy of the source?
2) what is the rate of information generated by this source in bits per second?

Code:

```
r=1/(1*10^-6);
disp(r);        //Message rate
p1=0.4;         //probability
p2=0.3;         //probability
p3=0.2;         //probability
p4=0.1;         //probability
I1=log2(1/p1);
//Information I2=log2(1/p2);
I3=log2(1/p3);
I4=log2(1/p4);
disp(I1);
disp(I2);
disp(I3);
disp(I4);
H=I1*p1+I2*p2+I3*p3+I4*p4;
disp(H);        //Entropy
R=r*H;
disp(R);        //Information Rate
```

Output:

```
1000000.
1.3219281
1.7369656
2.3219281
3.3219281
1.8464393
1846439.3
```