EXPERIMENT NO - 5

Huffman Coding

AIM:- Implementation of Huffman Code using SCILAB.

Theory:
Huffman code:

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.

$$\boxed{H=I1*P1+I2*P2+I3*P3+I4*P4}$$

Length of code (L) :-

$$\boxed{L=L1*P1+L2*P2+L3*P3+L4*P4}$$

Efficiency :
The efficiency of a coding system is the ratio of the average information per symbol to the average code length.

$$\boxed{E=H/L*100\ \%}$$

Redundancy :

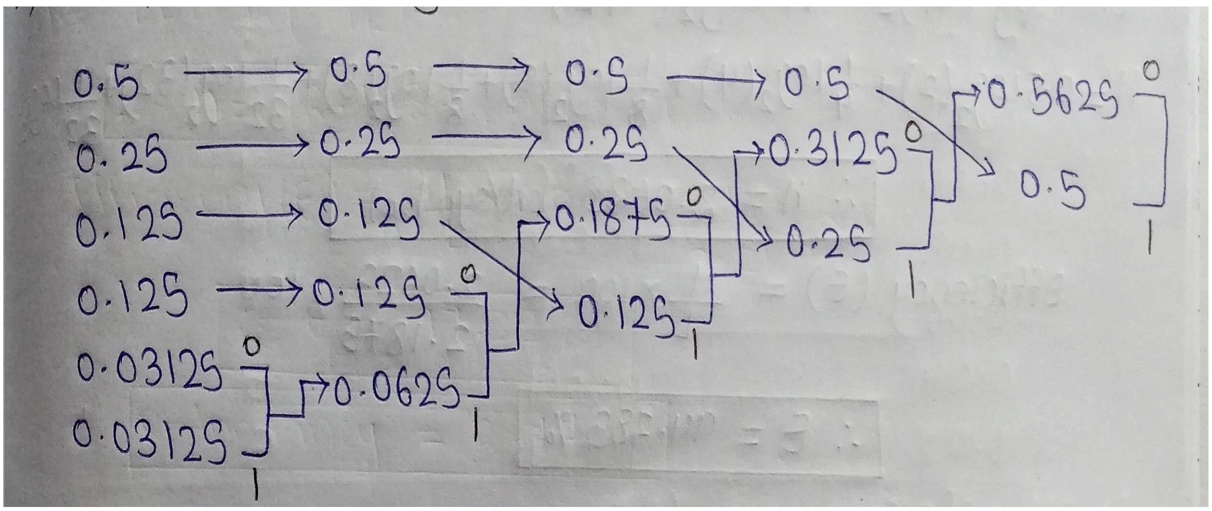
$$\boxed{R=100-E\ \%}$$

Problems:
Find Entropy, codeword length, efficiency and redundancy by using Huffman Coding of following data given :

Q1).

Messages	m1	m2	m3	m4	m5	m6
Probabilities	1/2	1/4	1/8	1/8	1/32	1/32

Solution:
Huffman Coding



Huffman Coding table

Messages	**Probabilities**	**Codeword**	**Codeword length**
m1	1/2	1	1
m2	1/4	10	2
m3	1/8	100	3
m4	1/8	0000	4
m5	1/32	01000	5

m6	1/32	11000	5

Code:

```
p1=1/2;         //probability
p2=1/4;         //probability
p3=1/8;         //probability
p4=1/8;         //probability
p5=1/32;
p6=1/32;
I1=log2(1/p1);    //Information
I2=log2(1/p2);
I3=log2(1/p3)
;
I4=log2(1/p4)
;
I5=log2(1/p5)
;
I6=log2(1/p6)
; disp(I1);
disp(I2);
disp(I3);
disp(I4);
disp(I5);
disp(I6);
H=I1*p1+I2*p2+I3*p3+I4*p4+I5*p5+I6*p6
; disp(H);   //Entropy
L1=1
;
L2=2
;
L3=3
;
L4=4
;
L5=5
;
L6=5
;
```

```
L=L1*p1+L2*p2+L3*p3+L4*p4+L5*p5+L6*p6;                    //length of code
disp(L);
E=(H/L)*100;
//Efficiency disp(E);
R=100-E;            //Redundancy
disp(R);
```

OUTPUT:

I1=1

I2=2

I3=3

I4=3

I5=5

I6=5

Entropy (H) = 2.0625

Length of code (L) = 2.1875

Efficiency (E)= 94.285714%

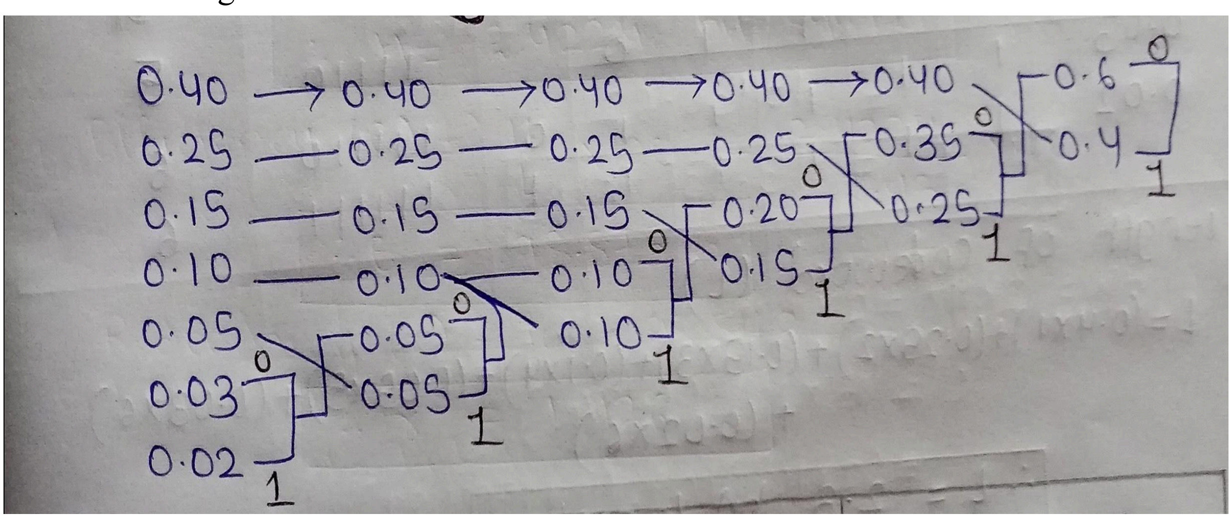
Redundancy(R) = 5.7142857%

Q2).

Messages	m1	m2	m3	m4	m5	m6	m7
Probabilities	0.40	0.25	0.15	0.10	0.05	0.03	0.02

Solution:

Huffman Coding



Huffman Coding table

Messages	Probabilities	Codeword	Codeword length
m1	0.40	1	1
m2	0.25	10	2
m3	0.15	100	3
m4	0.10	1000	4
m5	0.05	10000	5
m6	0.03	000000	6
m7	0.02	100000	6

Code:

```
p1=0.40;
//probability p2=0.25;
p3=0.15
;
p4=0.10
;
p5=0.05
;
p6=0.03
;
p7=0.02
;
I1=log2(1/p1);    //Information
I2=log2(1/p2);
I3=log2(1/p3)
;
I4=log2(1/p4)
;
I5=log2(1/p5)
;
I6=log2(1/p6)
;
```

```
I7=log2(1/p7)
; disp(I1);
disp(I2);
disp(I3);
disp(I4);
disp(I5);
```

```
disp(I6);
disp(I7);
H=I1*p1+I2*p2+I3*p3+I4*p4+I5*p5+I6*p6+I7*p7;
disp(H);     //Entropy
L1=1
;
L2=2
;
L3=3
;
L4=4
;
L5=5
;
L6=6
;
L7=6
;
L=L1*p1+L2*p2+L3*p3+L4*p4+L5*p5+L6*p6+L7*p7;         //length of code
disp(L);
E=(H/L)*100;
//Efficiency disp(E);
R=100-E;
//Redundancy disp(R);
```

OUTPUT :

I1=1.3219281

I2=2.

I3=2.7369656

I4=3.3219281

I5=4.3219281

I6=5.0588937

I7=5.6438562

Entropy (H) = 2.2522492

Length of code (L) = 2.3

Efficiency (E) = 97.923879 %

Redundancy(R) =2.0761206 %

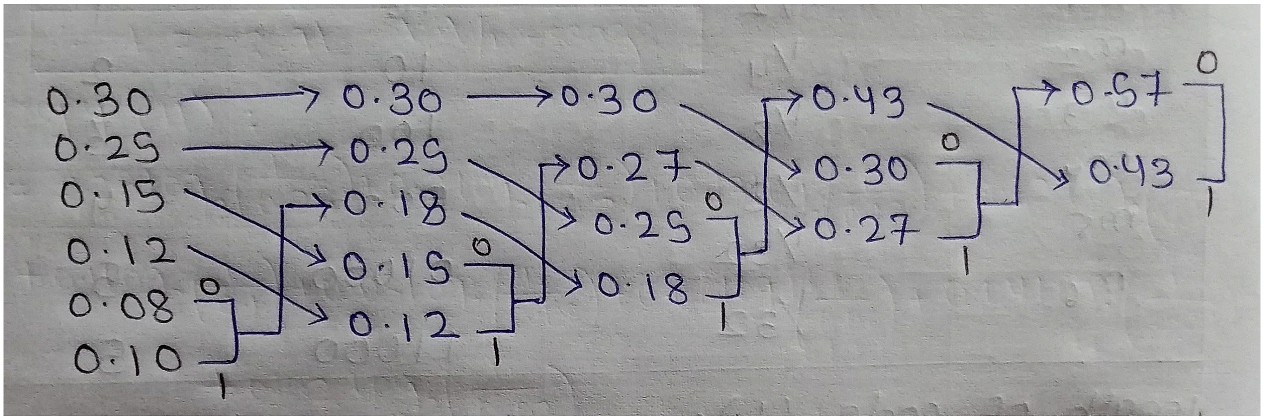
Q3).

Messages	m1	m2	m3	m4	m5	m6

Probabilities	0.30	0.25	0.15	0.12	0.08	0.10

Solution:

Huffman Coding



Huffman Coding table

Messages	Probabilities	Codeword	Codeword length
m1	0.30	00	2
m2	0.25	01	2
m3	0.15	100	3
m4	0.12	101	3
m5	0.08	110	3
m6	0.10	111	3

Code:

```
p1=0.30;
//probability p2=0.25;
p3=0.15
;
p4=0.12
;
p5=0.08
;
p6=0.10
;
I1=log2(1/p1);    //Information
```

```
I2=log2(1/p2);
I3=log2(1/p3);
```

```
I4=log2(1/p4)
;
I5=log2(1/p5)
;
I6=log2(1/p6)
; disp(I1);
disp(I2);
disp(I3);
disp(I4);
disp(I5);
disp(I6);
H=I1*p1+I2*p2+I3*p3+I4*p4+I5*p5+I6*p6
; disp(H);   //Entropy
L1=2
;
L2=2
;
L3=3
;
L4=3
;
L5=3
;
L6=3
;
L=L1*p1+L2*p2+L3*p3+L4*p4+L5*p5+L6*p6;        //length of code
disp(L);
E=(H/L)*100;
//Efficiency disp(E);
R=100-E;
//Redundancy disp(R);
```

OUTPUT:

I1= 1.7369656
I2= 2.
I3= 2.7369656
I4= 3.0588937
I5= 3.6438562

I6= 3.3219281

Entropy (H) = 2.4224031

Length of code (L) = 2.45

Efficiency (E) = 98.873594 %

Redundancy(R) = 1.1264055 %