Communication Theory Assignment 1 Report

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1 Modulated Signals

We are generating a random signal which has 2 symbols 1 and -1. It looks as follows. I use a uniform probability distribution and set a marker to decide if it is 1 or -1.

$$u_c(t) = \sum_{n=1}^{N} b_c[n]p(t-n)$$
$$u_s(t) = \sum_{n=1}^{N} b_s[n]p(t-n)$$

```
for n=1:10
    val1=randi([0 1],1);
    if(val1<0.5);val1=-1;else;val1=1;end
    val2=randi([0 1],1);
    if(val2<0.5);val2=-1;else;val2=1;end
    for i=(n-1):0.001:n
        index=round(i*1000)+1;
        uc(index)=val1;
        us(index)=val2;
    end
end
```

2 Baseband to Passband conversion

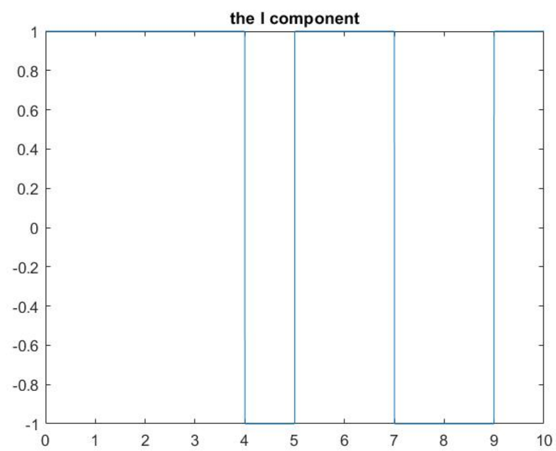
The baseband signal is converted to passband by mutliplying the signal with a cosine waveform whose frequency is the carrier frequency.

$$u_{p,1}(t) = u_c(t)cos40\pi t$$
$$u_{p,2}(t) = u_c(t)sin40\pi t$$
$$u_p(t) = u_{p,1}(t) - u_{p,2}(t)$$

```
for i=t
    index=round(i*1000)+1;
    up1(index)=uc(index)*cos(40*pi*i);
    up2(index)=us(index)*sin(40*pi*i);
    up(index)=up1(index)-up2(index);
end
```

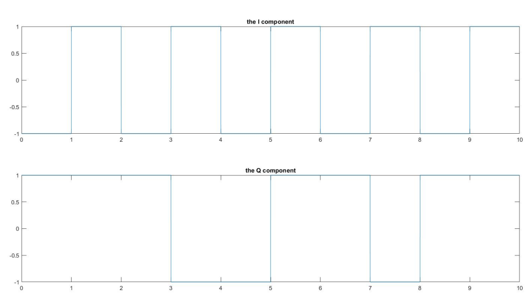
3 BPSK

The Binary phase shift keyed signal is over 2 symbols 1 and -1.



4 QPSK

The quarternary phase shift keyed signal is over 4 symbols : 2 from the I component and 2 from the Q component.



5 Downconversion

In this section I am assuming 0 offset in the signal due to the channel and the receiver. After the signal is received $\tilde{u}(t)$ it must be demodulated so that we can separate the high carrier frequency from the signal and obtain the actual message/baseband signal. This is done as follows: multiply by $2cos(2\pi f_c t)$ and $-2sin(1\pi f_c t)$

$$\tilde{u}_c(t) = 2u_p(t)cos(40\pi t)$$

$$\tilde{u}_s(t) = -2u_p(t)sin(40\pi t)$$

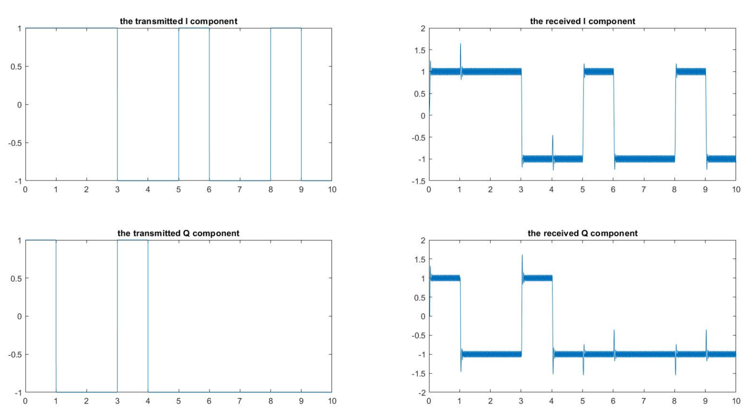
```
for i=t
    index=round(i*1000)+1;
    ucrec(index)=2*up(index)*cos(40*i*pi+theta);
    usrec(index)=-2*up(index)*sin(40*i*pi+theta);
end
```

The code below is to generate a filter

```
fc=10; % change this fre
fs=1000;
theta=0;
[b,a]=butter(6,2*fc/fs);

 vc=filter(b,a,ucrec);
 vs=filter(b,a,usrec);
```

These are the recovered signals v_c and v_s



6 Downconversion with removal of offset

We take the offset into consideration but we assume that the offset is known to us but in real life that is not the case. To remove the offset, we have to perform the steps below We know that $u(t) = \tilde{u}(t)e^{j\theta(t)}$.
So from this we can find out the relation between $u_c(t), \tilde{u}_c(t), u_s(t), \tilde{u}_s(t)$

$$u_c(t) = \tilde{u}_c(t)cos(\theta(t)) - \tilde{u}_s(t)sin(\theta(t))$$
$$u_c(t) = \tilde{u}_c(t)sin(\theta(t)) + \tilde{u}_s(t)cos(\theta(t))$$

```
for i=t
    index=round(i*1000)+1;
    vcoff(index)=vc(index)*cos(theta*index)-vs(index)*sin(theta*index);
    vsoff(index)=vs(index)*cos(theta*index)+vc(index)*sin(theta*index);
end
```