ECE 642 - Assignment 6

Recall that problems can be solved by using the concepts discussed during the lectures. *When plotting either by hand or with MATLAB, please label all the axes with specific numerical value and units of measure.* MATLAB may be used only when explicitly stated. Include your MATLAB code and plots.

1. We wish to study the effect of noise on an AM system. The message $m(t)$ is imported in MATLAB from the wav file "hw6.wav" as follows.

```
[m,fs]=wavread('hw6.wav'); %fs is the sampling frequency used
when sampling the message -- note that m is a vector of real numbers
L=length(m); %length of the message
```

a. Plot the magnitude of the Fourier transform of $m(t)$ and check that it is a baseband signal.

```
f=...;
plot(f,fftshift(...));
```

b. Generate a realization of the in-phase component of the noise $W_I(t)$, assumed to be a white Gaussian processes with zero mean and power $P_{W_I} = 0.1$. Then, calculate the absolute value of its Fourier tranform and check that it is spread out at all frequencies.

```
WI=sqrt(...)*randn(L,1); %This generates a realization of the
in-phase noise sequence
plot(...);
```

c. Play the noise through your speakers!

```
sound(WI,fs);
```

d. Generate a realization of the quadrature component of the noise $W_Q(t)$, assumed to be a white Gaussian processes with zero mean and power $P_{W_Q} = 0.1$. Obtain the baseband noise as $W_z(t) = W_I(t) + jW_Q(t)$.

```
WQ=sqrt(...)*randn(L,1); %This generates a realization of the
quadrature noise sequence
Wz=WI+j*WQ;
```

e. The received baseband signal is given by $Y_z(t) = m(t)e^{j4/9\pi} + W_z(t)$ (we have set $A_c = 1$). Note that $\phi_P = 4/9\pi$ is the phase shift due to the channel. Generate this signal in MATLAB.

```
Yz=m*exp(...)+Wz;
```

f. The receiver performs the operation $\text{Re}\{Y_z(t)\}$ without compensating for the phase shift. Check how it sounds.

```
Mhat=real(Yz);
sound(Mhat,fs);
```

g. The receiver now performs phase compensation as $\text{Re}\{Y_z(t)e^{-j4/9\pi}\}$. Does it sound better?

h. Look at the spectrum of $m(t)$ plotted at point a. As you can see, most of the energy is concentrated between the frequencies $[-2\ kHz, 2\ kHz]$. Therefore, in order to reduce the noise, we can try to perform low-pass filtering of $Y_z(t)$ in this band before compensating for the phase. Please comment on the effect that it has on the way the signal sounds.

```
H=(f>=...)&(f<=...);
YzFourier=fftshift(fft(Yz))*Ts;
YzFourierfiltered=YzFourier.*H';
Yzfiltered=(ifft(ifftshift(YzFourierfiltered)))*1/Ts;
Mhat1=real(Yzfiltered*exp(-j...));
sound(Mhat1,fs);
```

2. Generate $N = 1000$ binary random variables X with $\Pr(X = 1) = 0.8$ in MATLAB and report the fraction of ones that you observe. Repeat with $N = 10000$ and $N = 100000$. What is happening?