Course Name: Analog Communication
MATLAB Experiment-5

Objective: Design two low pass filters with transfer function, $H_1(s) = \frac{1}{s+1}$ i.e. linear phase and $H_2(s) = \frac{1}{s^2+s+1}$, i.e. non-linear phase. Find the response of the multi-tone signal $x(t) = 0.5 * cos(2 * \pi * 10 * t) + cos(2 * \pi * 20 * t) - 0.2 * cos(2 *\pi* 30 * t)$ for two filters. Draw the amplitude, phase spectra of the filters, and compare them. Also, comment to the obtained results.

MATLAB Code:

```
t=0:0.001:10;    % time scale
k=0:1:10000;    % samples of fft
x=0.5*cos(2*pi*10*t)+cos(2*pi*20*t)-0.2*cos(2*pi*30*t);   % input with some phase & frequency
h(t>=0)=exp(-t);          % impulse response of linear filter
h1(t>=0)=(2/1.732)*exp(-0.5*t).*sin(1.732*0.5*t);         % impulse response of non-linear filter
H=fft(h);          % 10001 samples of Fourier transform of linear filter
H1=fft(h1);        % 10001 samples of Fourier transform of non-linear filter
X=fft(x);          % Fourier transform of input
Y=H.*X;            % frequency response of linear filter
Y1=H1.*X;          % frequency response of non-linear filter
y=ifft(Y);         % time domain response of linear filter
y1=ifft(Y1);       % time domain response of non-linear filter
subplot(321)
plot(t,x)
xlabel('time(sec)');
ylabel('x(t)');
legend('Input Signal')
subplot(322)
plot(t,0.001*y)
xlabel('time(sec)');
ylabel('y(t)');
legend('Filtered Response Linear Filter')
title('Linear Filter')
subplot(323)
plot(t,0.001*y1)
xlabel('time(sec)');
ylabel('y(t)');
legend('Filtered Response Non-Linear Filter')
title('Non-Linear Filter')
subplot(324)
plot(k,0.001*abs(H),k,0.001*abs(H1))
xlabel('frequency(Hz)');
ylabel('Magnitude Response');
legend('Linear Filter','Non-Linear Filter')
title('Magnitude Response')
subplot(325)
plot(k,angle(H),k,angle(H1))
```

```
xlabel('frequency(Hz)');
ylabel('Phase Response');
legend('Linear Filter','Non-Linear Filter')
title('Phase Response');
```

Result: