# Lab Report – 2

## ECS 330 : Experiment: Filter Design

**Name:** Ajay Choudhury (18018) **Date of Submission:** 27th January 2021

## Solutions

**Q.1.** Solution

**Code:**

```
1. syms t w;
2. f1 = 20;
3. f2 = 40;
4. f3 = 60;
5. x = cos(2*pi*f1*t) + cos(2*pi*f2*t) + cos(2*pi*f3*t);
6. ft = fourier(x, t, w)
```

**Output:**

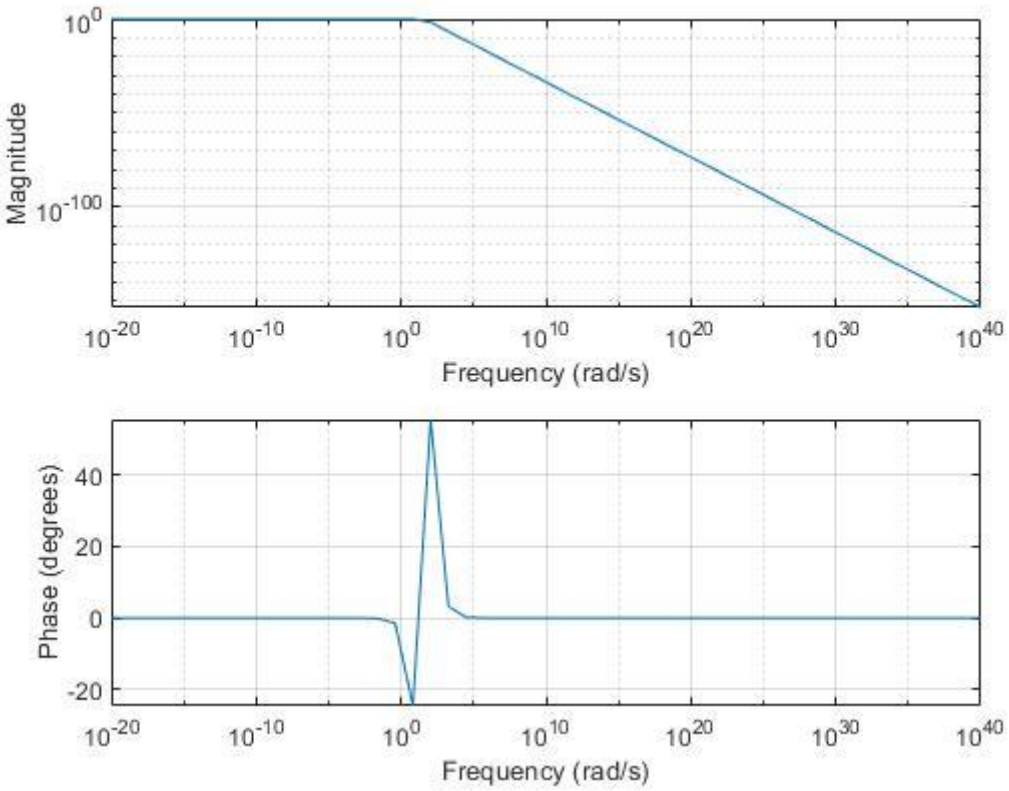
```
1. ft = pi*(dirac(w - 40*pi) + dirac(w + 40*pi)) + pi*(dirac(w - 80*pi) + dirac(w +
   80*pi)) + pi*(dirac(w - 120*pi) + dirac(w + 120*pi))
```

**Q.2.** Solution

**Code:**

```
1. [b , a] = butter (4, 40, 's');
2. wband = logspace(-20, 40);
3. freqs(b, a, wband);
```

**Figure:** (On Next Page)




**Q.3.** Solution

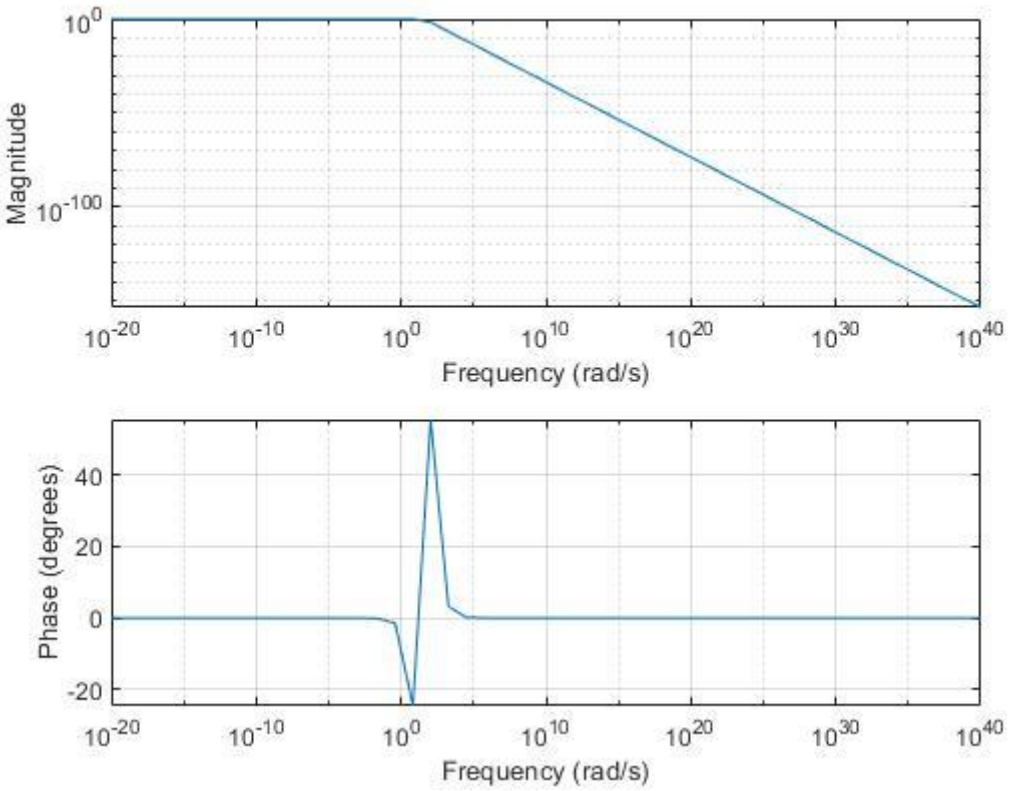
**Code:**

```
1. [b , a] = butter (4, 40, 's');
2. wband = logspace(-20, 40);
3. freqs(b, a, wband);
4.
5. H(w) = poly2sym(b, w) / poly2sym(a, w)
```

**Output:**

```
1. H(w) = 2560000/(w^4 + (3677647801095837*w^3)/35184372088832 +
   (1501587004615895*w^2)/274877906944 + (718290586151531*w)/4294967296 + 2560000)
```

**Figure:**




**Q.4.** Solution

**Code:**

```
1. Y(w) = H(w).*ft;
2. y(t) = ifourier(Y,w,t);
```

**Output:**

```
1. y(t) = ((4398046511104000*pi*exp(-pi*t*80i))/(70368744177664000*pi^4 -
   91941195027395925*pi^3 + 60063480184635800*pi^2 - 22985298756848992*pi +
   4398046511104000) + (4398046511104000*pi*exp(pi*t*80i))/(70368744177664000*pi^4 +
   91941195027395925*pi^3 + 60063480184635800*pi^2 + 22985298756848992*pi +
   4398046511104000) + (35184372088832000*pi*exp(-pi*t*40i))/(35184372088832000*pi^4
   - 91941195027395925*pi^3 + 120126960369271600*pi^2 - 91941195027395968*pi +
   35184372088832000) + (35184372088832000*pi*exp(pi*t*40i))/(35184372088832000*pi^4
   + 91941195027395925*pi^3 + 120126960369271600*pi^2 + 91941195027395968*pi +
   35184372088832000) + (35184372088832000*pi*exp(-
   pi*t*120i))/(284993413919539200*pi^4 - 2482412265739689975*pi^3 +
   1081142643323444400*pi^2 - 275823585082187904*pi + 35184372088832000) +
   (35184372088832000*pi*exp(pi*t*120i))/(284993413919539200*pi^4 +
   2482412265739689975*pi^3 + 1081142643323444400*pi^2 + 275823585082187904*pi +
   35184372088832000))/(2*pi)
```

**Q.5.** Solution

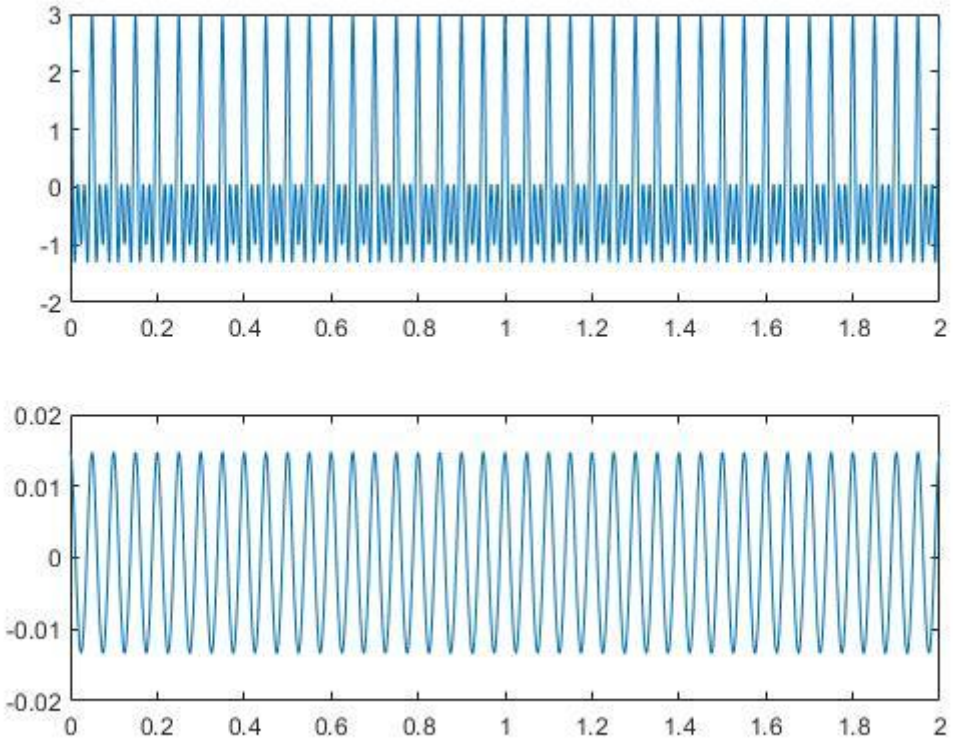
**Code:**

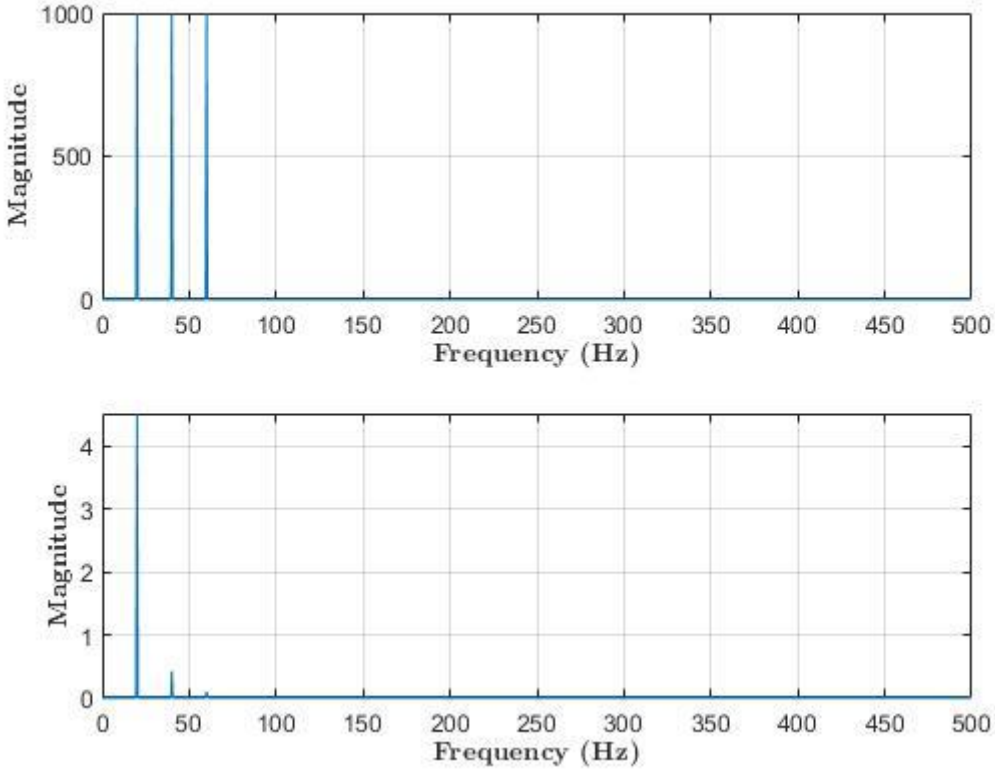
```
fs = 1000;
t1 = 0:1/fs:2-1/fs;
x_numeric = double(subs(x,t,t1));
y_numeric = double(subs(y,t,t1));
figure
subplot(2,1,1)
plot(t1,x_numeric)
subplot(2,1,2)
plot(t1,y_numeric)

 ylim=[-4,4];
 Y_NUM=fft(y_numeric);
 X_NUM=fft(x_numeric);
 n=length(X_NUM);
 f=(0:n-1)*fs/n;
 figure;
 subplot(2,1,1);
 plot(f(1:floor(length(X_NUM)/2)), abs(X_NUM(1:floor(length(X_NUM)/2))));
 xlabel('\textbf{Frequency (Hz)}', 'Interpreter', 'latex');
 ylabel('\textbf{Magnitude}', 'Interpreter', 'latex');
 grid;
 subplot(2,1,2);

 plot(f(1:floor(length(Y_NUM)/2)), abs(Y_NUM(1:floor(length(Y_NUM)/2))));
 xlabel('\textbf{Frequency (Hz)}', 'Interpreter', 'latex');
 ylabel('\textbf{Magnitude}', 'Interpreter', 'latex');
 grid;
```

**Figures:**




1000
500
0
Magnitude
0
50
100
150
200
250
300
350
400
450
500
Frequency (Hz)


4
3
2
1
0
Magnitude
0
50
100
150
200
250
300
350
400
450
500
Frequency (Hz)