Submitted By:

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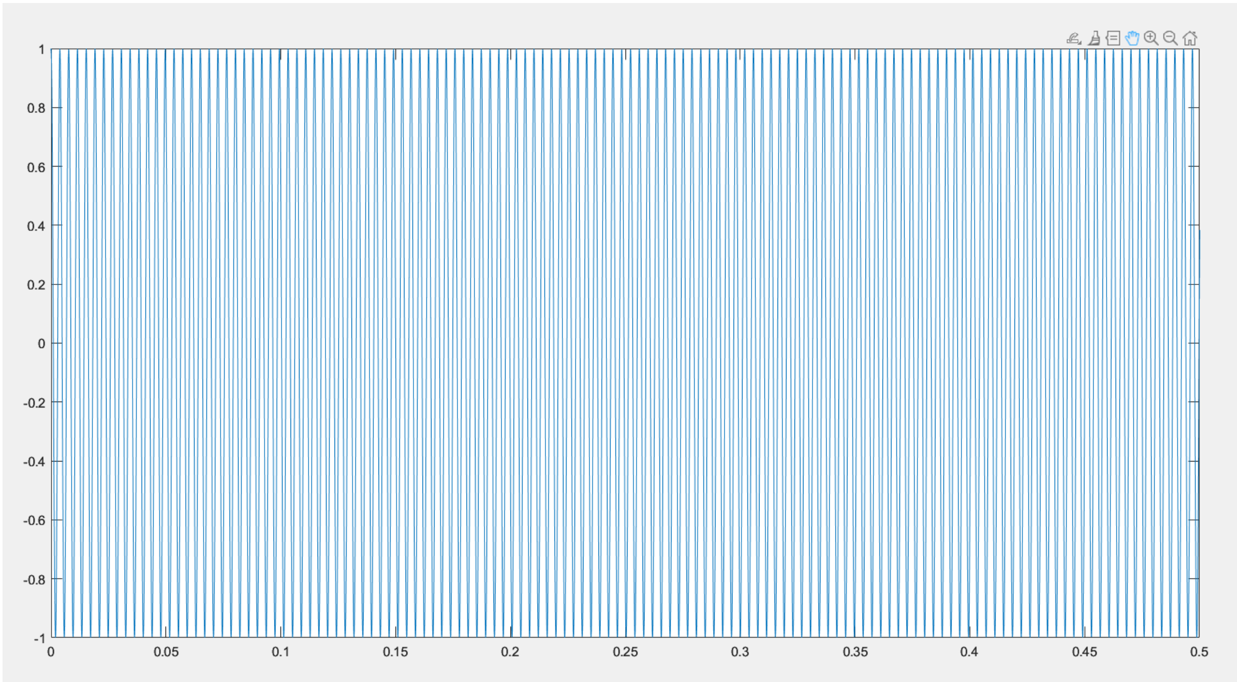
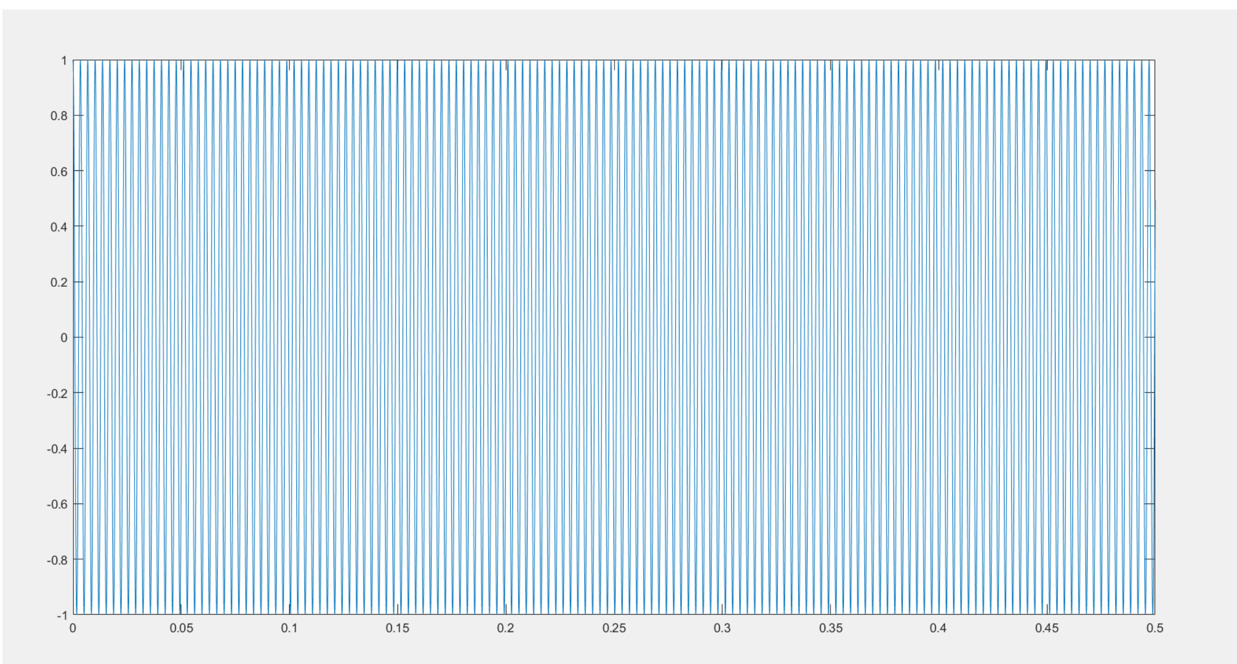
1. Do wave:

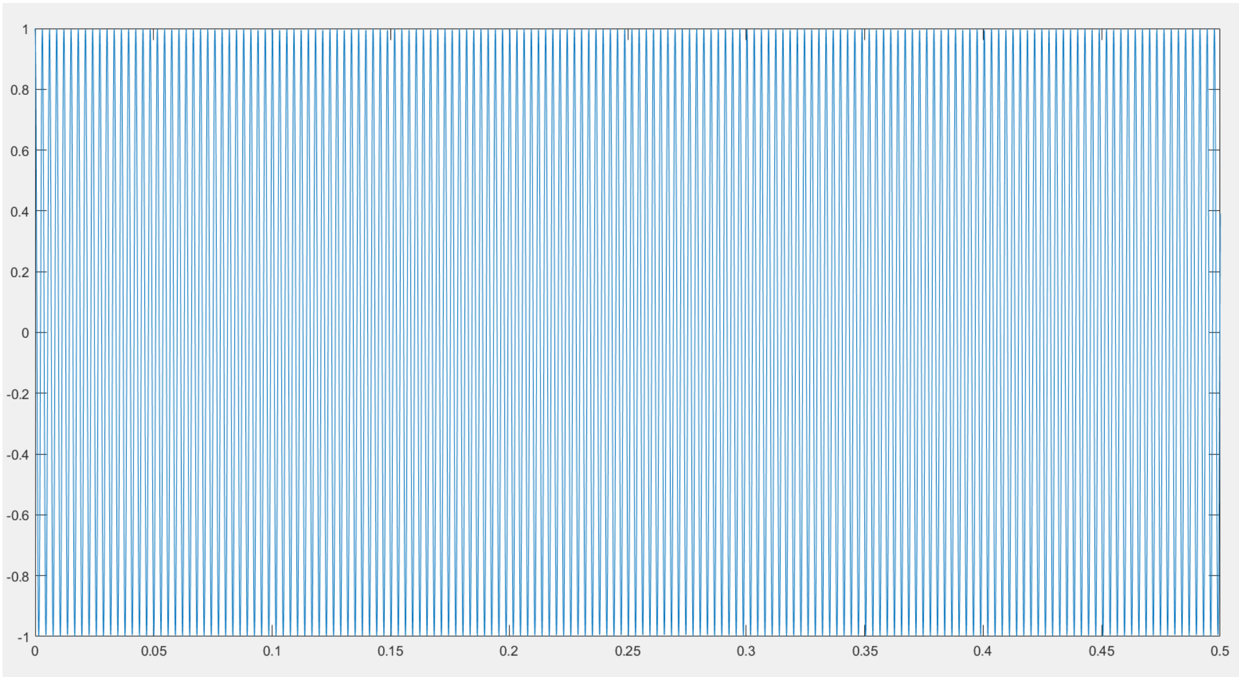


2. Re wave:

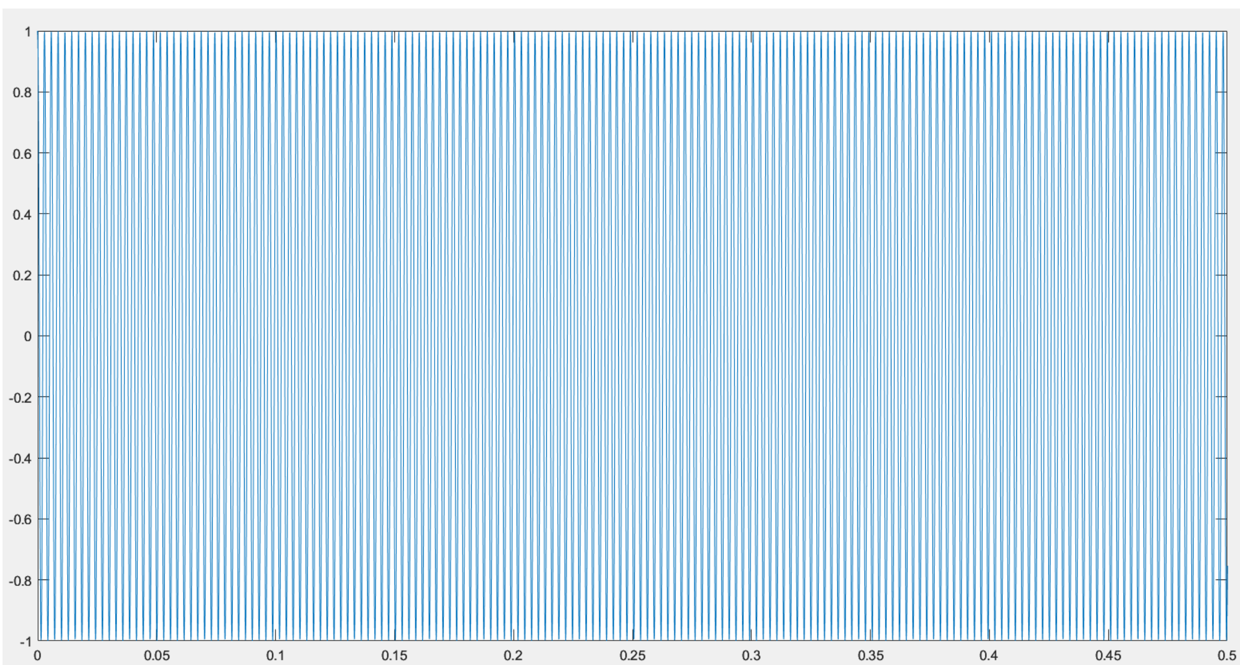
:



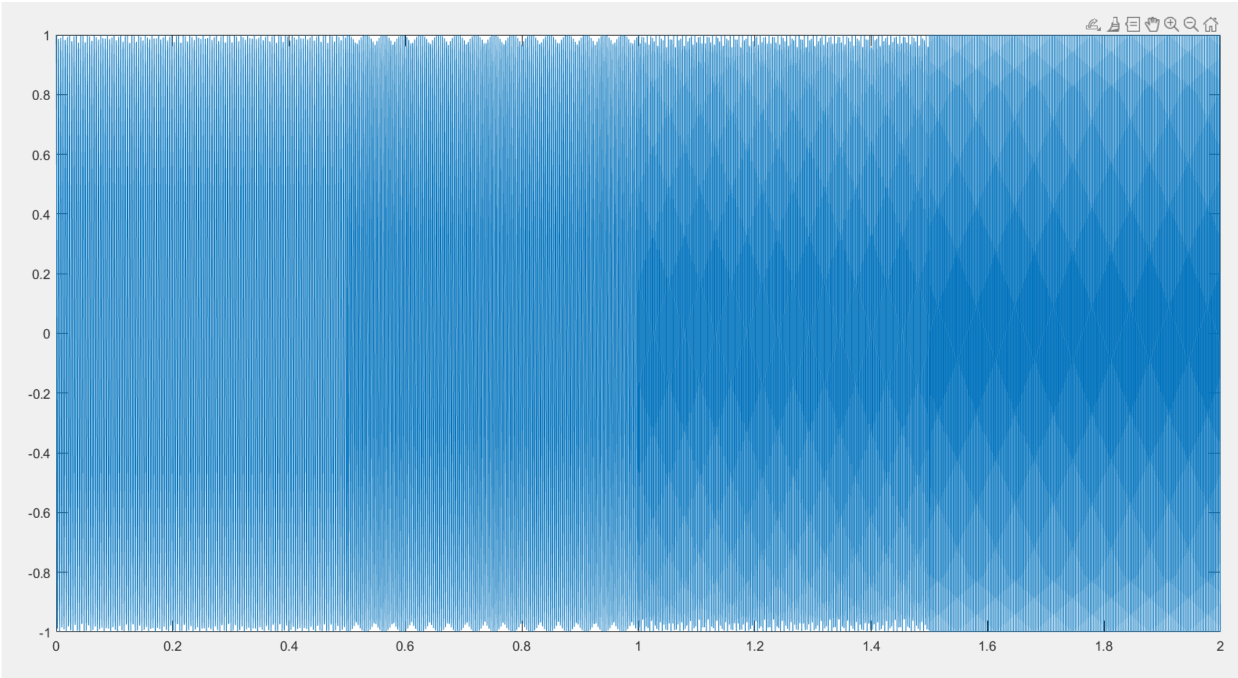
3. Me wave:



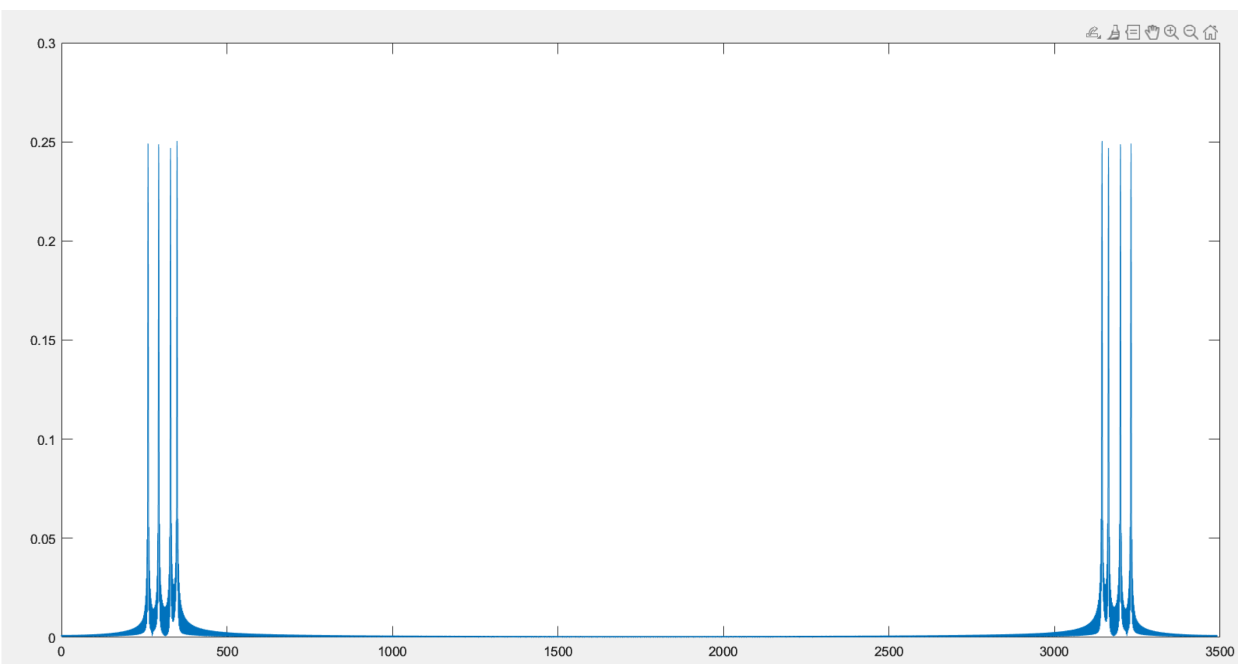
4. Fa wave:



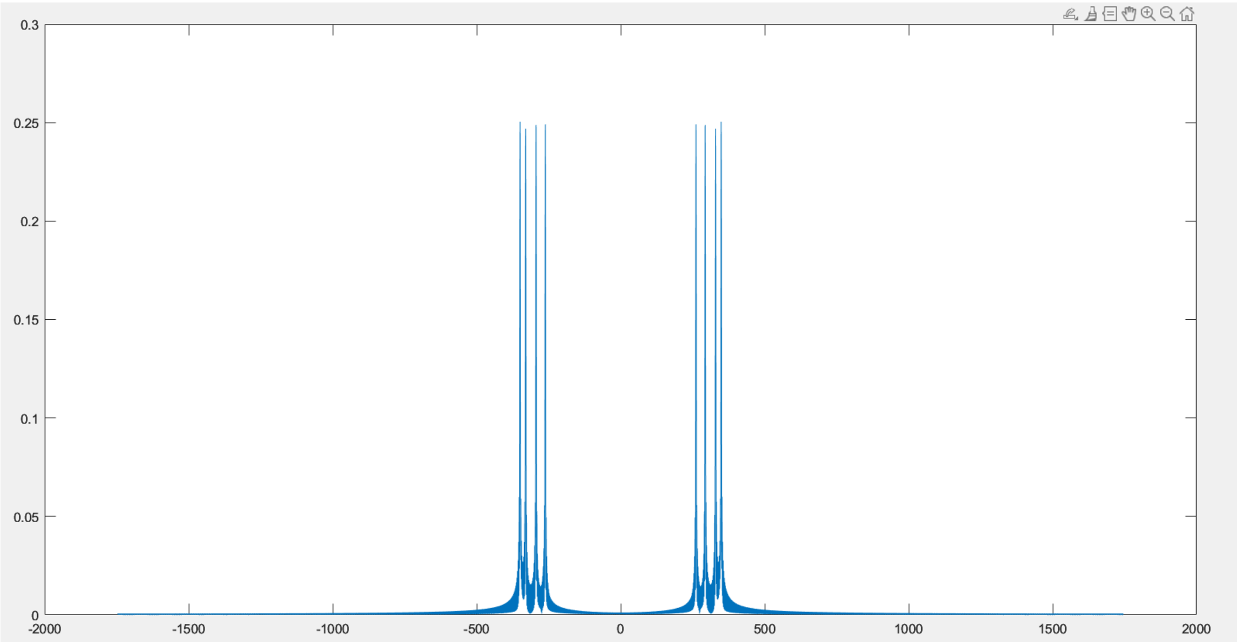
5. Concatenation of do re mi fa waves in a single wave:



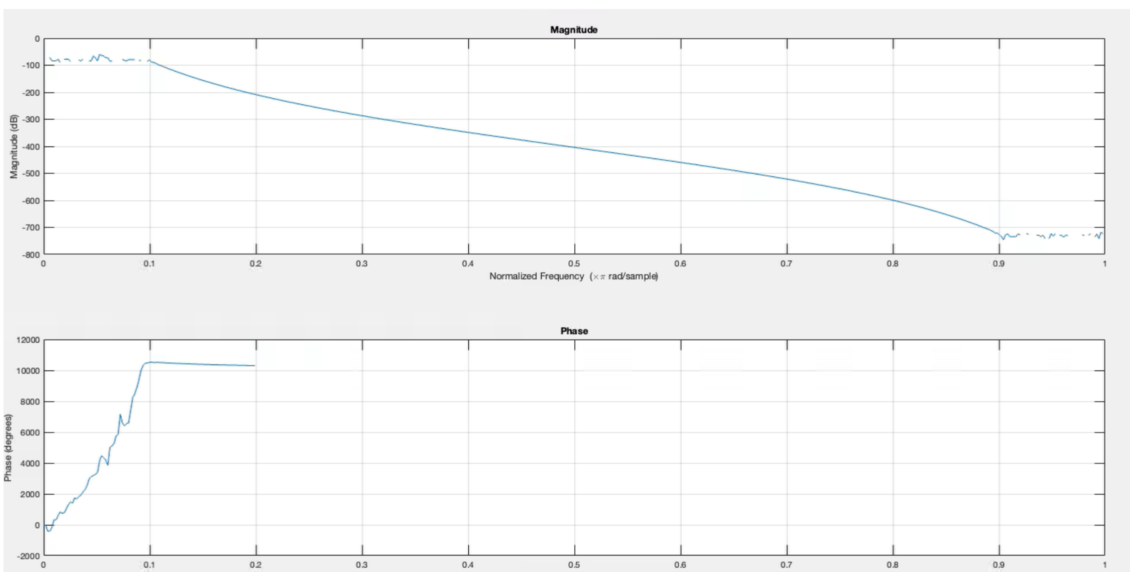
6. Fourier Transform of the do re me fa wave:



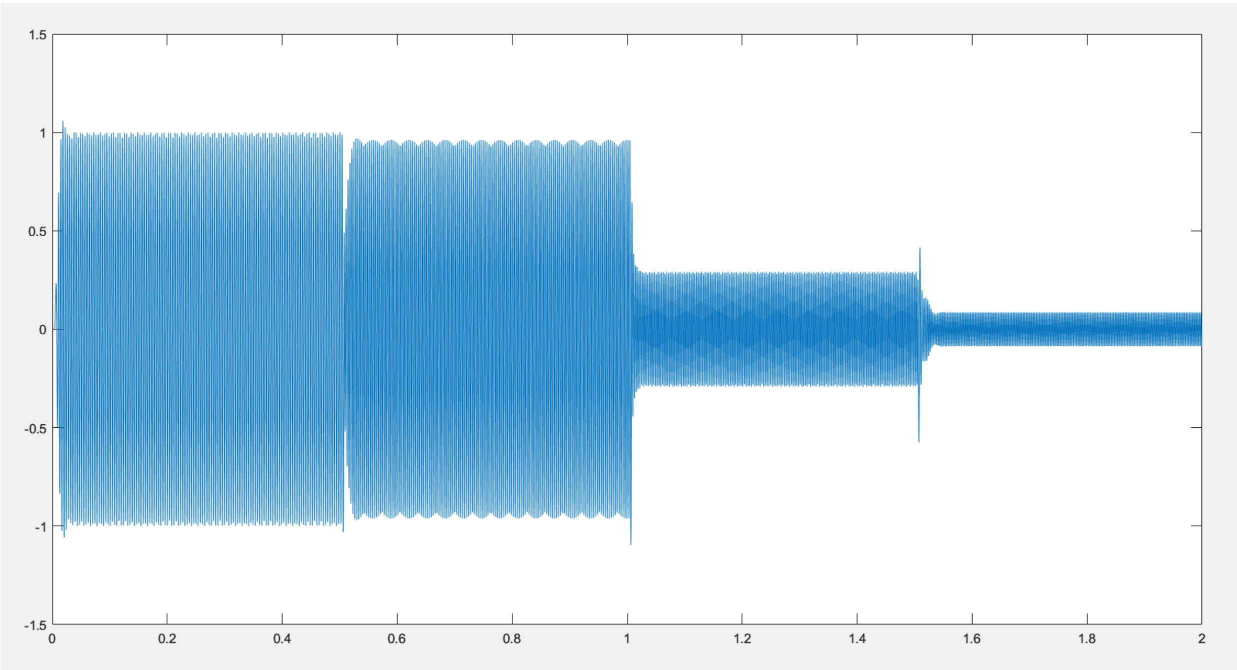
7. Shifted version of fourier transform of do re me fa wave:



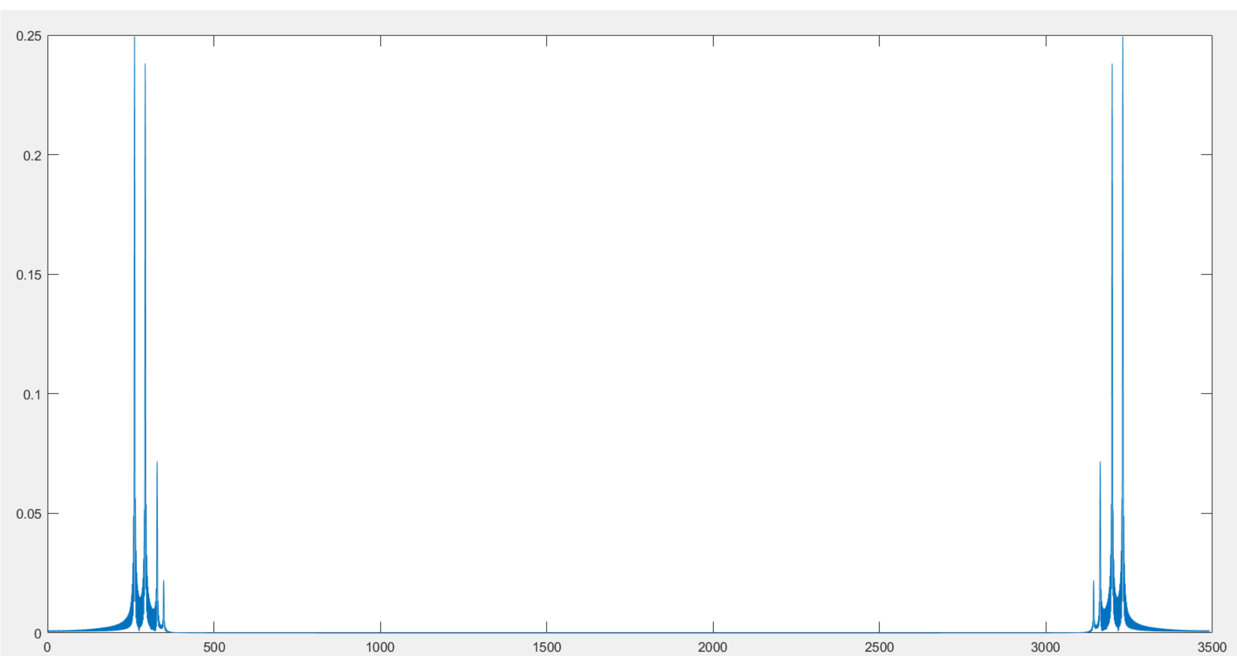
8. Magnitude and phase of the low pass butterworth filter:



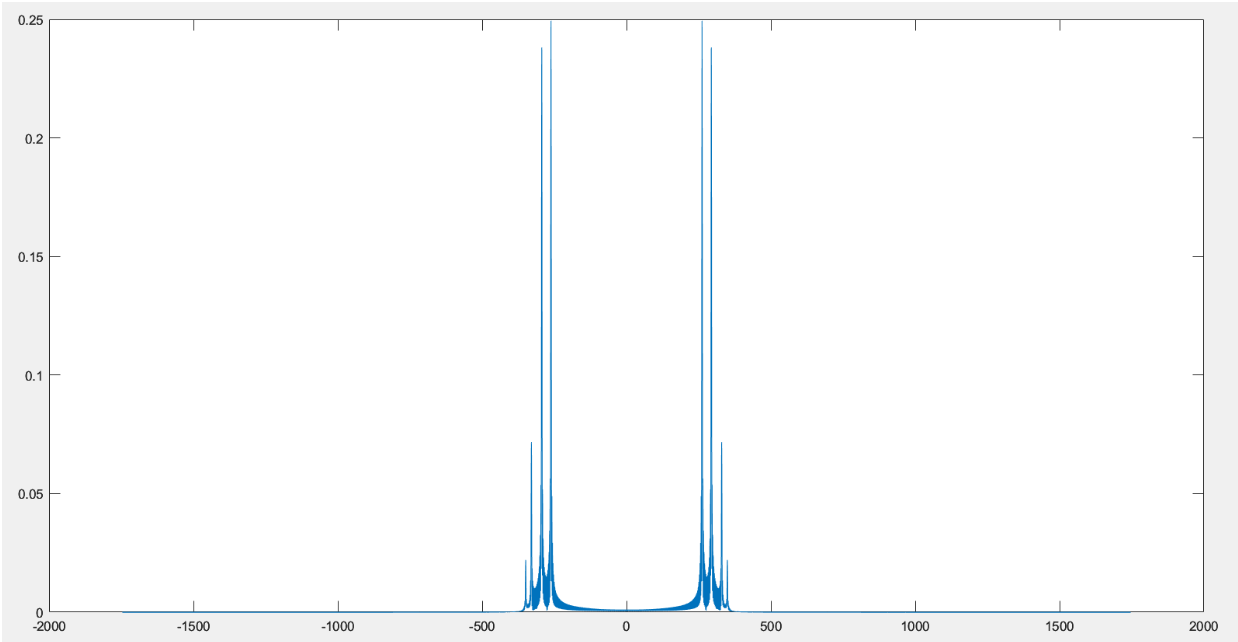
9. Applying low pass butterworth filter on do re mi fa wave:



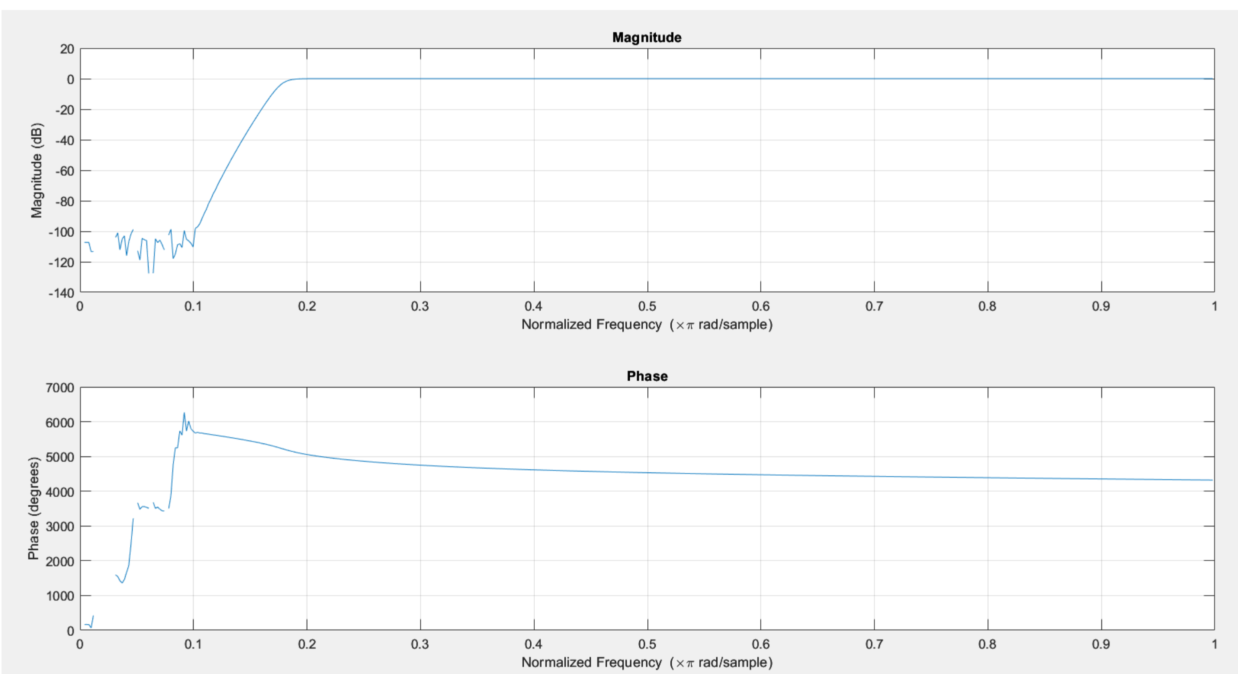
10. Fourier Transform of signal after applying low pass filter:



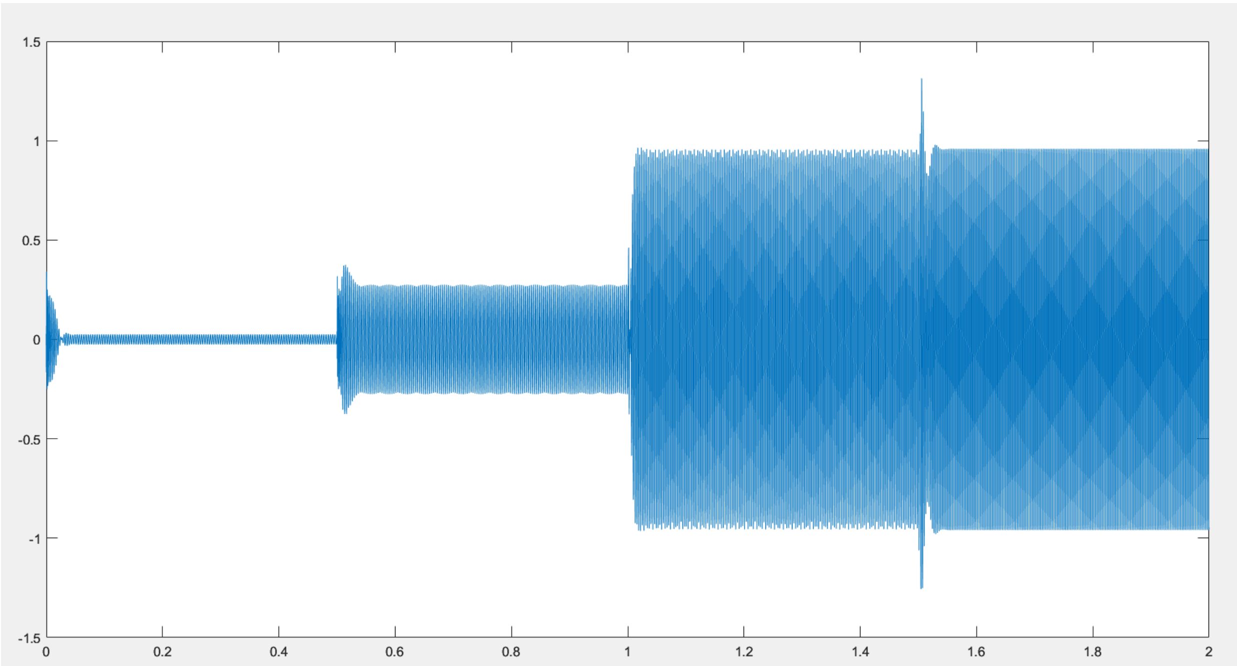
11. Shifted version of 10 around zero:



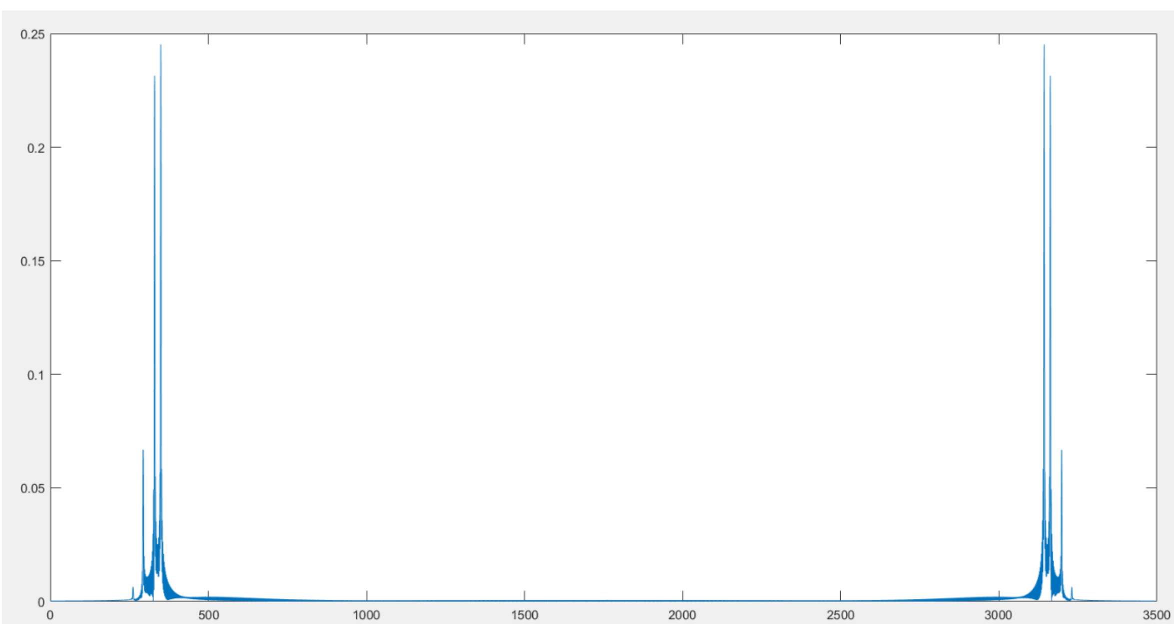
12. Magnitude and phase of high pass butterworth filter:



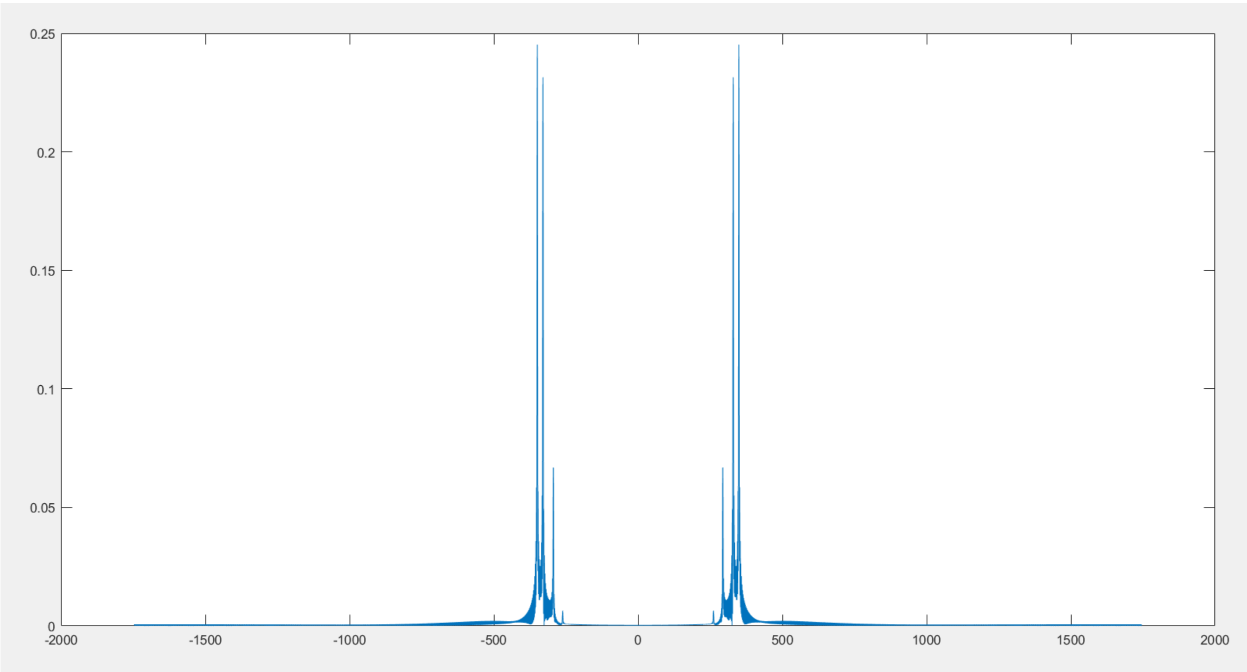
13. Output of applying do re mi fa signal on high pass filter:



14. Fourier Transform of signal after applying high pass filter:



15. Shifted version of 14 around zero:

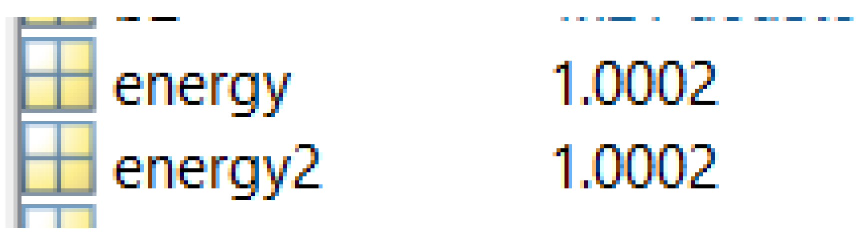


16. Matlab Commands applied:

```
fdo = 440*power(2,-9/12);
>> fre = 440*power(2,-7/12);
>> fmi = 440*power(2,-5/12);
>> ffa = 440*power(2,-4/12);
>> fs = 10 * max([fdo,fre,fmi,ffa]);
>> N = round(0.5 * fs);
>>t = 0:1:N-1;
>> t=t/fs;
>> x1=cos(2*pi*fdo*t);
>> x2=cos(2*pi*fre*t);
>> x3=cos(2*pi*fmi*t);
>> x4=cos(2*pi*ffa*t);
>> xt = [x1,x2,x3,x4];
>> N = N*4;
>> t = 0:1:N-1;
>> t=t/fs;
>> plot(t,xt);
>> sound(xt,fs);
>> audiowrite('wave.wav',xt,round(fs));
>> [b, a] = butter(20, ((fre+fmi)/2)/(fs/2));
>> yt = filter(b,a,xt);
>> sound(yt,fs)
>> sound(yt,fs)
>> plot(t,yt);
>> plot(t,xt);
>> audiowrite('wavefilter.wav',yt,round(fs));
>> energy = sum(power(xt,2)/fs);
>> xf = fft(xt,N);
>> energy2 = sum(abs(xf).^2) * (fs/N);
>> plot(t,yt);
>> energy_yt = sum(power(yt,2)/fs);
>> fshift = (-N/2:1:(N/2)-1)*(fs/N);
>> plot(fshift,yf);
>> plot(f,yf);
>> plot(f,fftshift(xf));
>> plot(fshift,fftshift(xf));
>> plot(fshift,fftshift(yf));
>> energy_yf = sum(abs(yf).^2) * (fs/N);
```

```
>> yf = fft(yt,N)/fs;
>> energy_yt2 = sum(power(yt2,2)/fs);
>> yf2 = fft(yt2,N)/fs;
>> energy_yf2 = sum(abs(yf2).^2) * (fs/N);
>> [b2, a2] = butter(20, ((fre+fmi)/2)/(fs/2) , 'high');
>> freqz(b2,a2);
>> yt2 = filter(b2,a2,xt);
>> sound(yt2,fs);
>> sound(yt2,fs);
>> sound(yt2,fs);
>> sound(yt2,fs);
>> sound(yt2,fs);
>> sound(yt2,fs);
>> plot(t,yt2);
>> audiowrite('highpass.wav',yt2,round(fs));
>> plot(f,yf2);
>> plot(fshift,fftshift(yf2));
>> plot(f,abs(xf));
>> plot(fshift,fftshift(abs(xf)));
>> plot(f,abs(yf));
>> plot(fshift,fftshift(abs(yf)));
>> plot(f,abs(yf2));
>> plot(fshift,fftshift(abs(yf2)));
```

17. Energy obtained from do re mi fa signal and it’s fourier transform:



18. Energy obtained from applying do re mi fa signal on low pass filter and its fourier transform:

energy_yt	0.5016	energy_yf	0.5016

19. Energy obtained from applying do re mi fa signal on high pass filter and its fourier transform:

energy_yt2	0.4941	energy_yf2	0.4941

Parseval’s relation approved

20. Appropriate sampling frequency = 10 * max(261.62,349.22,329.63,293.66) = 10*349.63 = 3496

21. Cut off frequency for filters = (Fmi+Fre)/2 = (329.63+293.66)/2=311.65

- Team members Contribution:

  Karim Bassel Samir : steps 1,2,10,11,12,13

  Matthew Sherif Shalaby: steps 3,4,14,15,16,17

  Fady Fady Fouad: steps 5,6,18,19,20,21

  Shady Emad Sabry: steps 7,8,9,22,23,24,25