**Faculty of Engineering ,Ain Shams University.**

Computer Engineering and Software Program.

Project Document

ECE 251 : Signals and Systems Fundamentals– Fall 2021

Graphical user interface, text, application

Description automatically generated

# Code:

*f1=500;*

*f2=1000;*

*f3=1500;*

*f4=2000;*

*fs= 10\*max([f1,f2,f3,f4]);*

*ts=1/fs;*

*frmsize=2048;*

*t=(0:1:frmsize-1)\*ts;*

*xt=cos(2\*pi\*f1\*t)+cos(2\*pi\*f2\*t)+cos(2\*pi\*f3\*t)+cos(2\*pi\*f4\*t);*

*plot(t,xt);*

*audiowrite('xt.wav',xt,fs);*

*energy= sum(power(abs (xt),2))\*ts;*

# Graphical user interface, text, application Description automatically generatedEnergy:

**Energy:0.2062**

# Graphs:

Chart, histogram

Description automatically generated

Figure 1 x(t)

Zoomed in>>

A screenshot of a computer

Description automatically generated with medium confidence

Text

Description automatically generated

# Code:

*delta\_f=fs/frmsize;*

*f=(-(frmsize/2):1:((frmsize/2)-1))\*delta\_f;*

*xf=fftshift(fft(xt,frmsize))/fs;*

*energy= sum(power(abs (xf),2))\*delta\_f;*

*plot(f,abs(xf));*

# Energy:

Graphical user interface, text, application

Description automatically generated

**Energy:0.2062**

**Parseval Theorem proved**

**E(X1)= E(XF)**

# Graphs:

Graphical user interface, chart, histogram

Description automatically generated

Figure 2 X(f) frequency spectrum

**zoomed in >>**

A screenshot of a computer

Description automatically generated with medium confidence

Text

Description automatically generated

Text

Description automatically generated

# Code:

# *pkg load signal*

# *fc = 1250/(fs/2);*

# *[b,a] = butter (20,fc);*

# *y1 = filter (b,a,xt);*

# *y1f= fftshift(fft(y1,frmsize))\*ts;*

# *energy= sum(power(abs (y1),2))\*ts;*

# *energy= sum(power(abs(y1f),2))\*delta\_f;*

# *audiowrite('lowpass.wav',y1,fs);*

# *plot(f,abs(y1f))*

# *plot(t,abs(y1))*

# *freqz(b,a);*

# Energy:

Graphical user interface, text, application

Description automatically generated

**Energy of signal y1(t): 0.1007**

Graphical user interface, text, application

Description automatically generated

**Energy from frequency spectrum y1f= 0.1007**

**Parseval Theorem proved**

**E(Y1)= E(Y1F)**

# Chart Description automatically generated Graphs:

Figure 3 y1(t) in time domain

**zoomed in>>**

A picture containing text

Description automatically generated

Graphical user interface, chart

Description automatically generated

Figure 4 frequency spectrum y1(t)

Figure 7 y1(t)

Figure 8 y1(t)

Figure 9 y1(t)

**Zoomed in >>**

Graphical user interface, chart, histogram

Description automatically generated

Chart, line chart

Description automatically generated

Figure 5 phase & magnitude and phase response of the Butterworth LPF

Graphical user interface, text, application

Description automatically generated

# Code:

# *[d,c] = butter (20,fc,'high');*

# *y2 = filter (d,c,xt);*

# *y2f = fftshift(fft(y2,frmsize))\*ts;*

# *energy= sum(power(abs (y2),2))\*ts;*

# *energy= energy= sum(power(abs(y2f),2))\*delta\_f;*

# *audiowrite('highpass.wav',y2,fs);*

# *plot(f,abs(y2f))*

# *plot(t,abs(y2))*

# *freqz(d,c);*

# Energy:

Graphical user interface, text, application

Description automatically generated

**Energy of signal y2= 0.1015**

Graphical user interface, text, application

Description automatically generated

**Energy from frequency spectrum of signal y2 (y2f)= 0.1015**

**Parseval Theorem proved**

**E(Y2)=E(Y2F)**

# Graphs:

Chart

Description automatically generated

Figure 6 y2(t) in time domain

Graphical user interface, application, Word

Description automatically generated**Zoomed in>>**

Graphical user interface, chart

Description automatically generated

Figure 7 frequency spectrum of y2(t)

Figure 13 y2(t)

Figure 14 y2(t)

Figure 15 y2(t)

**Zoomed in>>**

Graphical user interface, chart

Description automatically generated

Chart, line chart

Description automatically generated

Figure 8 magnitude and phase response of the Butterworth HPF