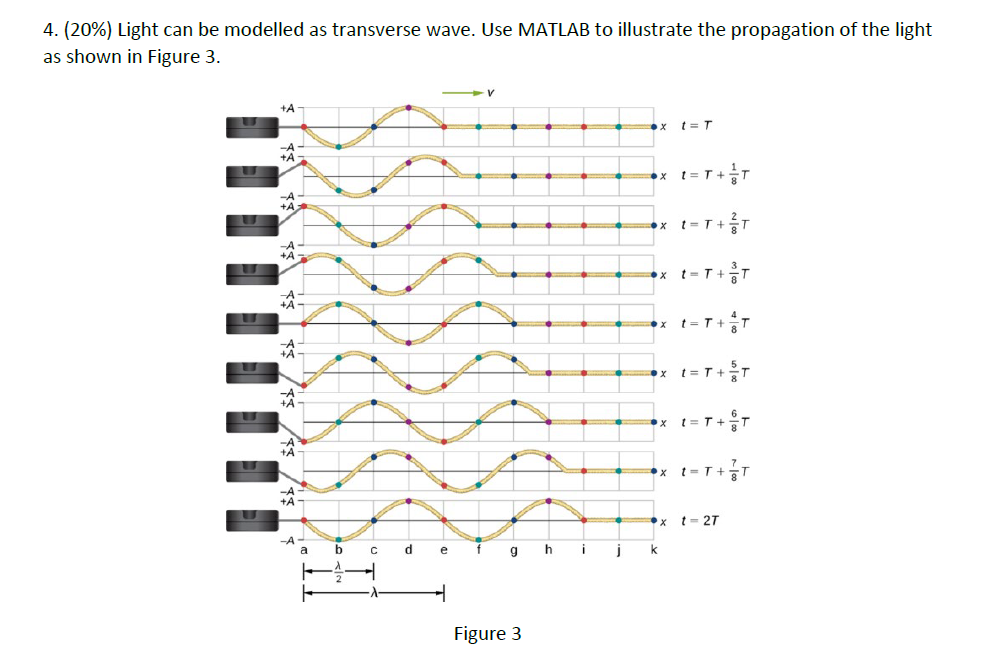
Problem 4



%---------------------------------------------------------------------

% file name : hmwk\_1\_prob\_4.m

% Student: Ray Duran

% Date: 9/12/21

% Class : EECS 590 Professor Liang, Fall Semester

% University of North Dakota

% Descr: Model traverse wave nature of light

%---------------------------------------------------------------------

A = 1;

t = [-3\*pi:pi/8:2\*pi]

y\_leading\_zeros = zeros(1,83);

y = sin(t - pi );

% pad zeros in front of wave

y\_padded = [ y y\_leading\_zeros];

%plot(t,y)

debug = 1;

t\_sample = 1 : 100;

% initial position

figure(1)

subplot(9,1,1)

plot(t\_sample,y\_padded(t\_sample+24))

axis([0 42 -1.1 1.1]);

title('Tranverse Wave Propagated Initial t = T')

% Transverse wave at 1/8T

y\_at\_18 = circshift(y\_padded,2);% propagate for light ; In model just do a circular shift

subplot(9,1,2)

plot(t\_sample,y\_at\_18(t\_sample+24))

axis([0 42 -1.1 1.1]);

title(' Tranverse Wave Propagated t = T + 1/8T')

% Transverse wave at 2/8T

y\_at\_28 = circshift(y\_padded,4);% propagate for light ; In model just do a circular shift

subplot(9,1,3)

plot(t\_sample,y\_at\_28(t\_sample+24))

axis([0 42 -1.1 1.1]);

title(' Tranverse Wave Propagated t = T + 2/8T')

% Transverse wave at 3/8T

y\_at\_38 = circshift(y\_padded,6);% propagate for light ; In model just do a circular shift

subplot(9,1,4)

plot(t\_sample,y\_at\_38(t\_sample+24))

axis([0 42 -1.1 1.1]);

title(' Tranverse Wave Propagated t = T + 3/8T')

% Transverse wave at 4/8T

y\_at\_48 = circshift(y\_padded,8);% propagate for light ; In model just do a circular shift

subplot(9,1,5)

plot(t\_sample,y\_at\_48(t\_sample+24))

axis([0 42 -1.1 1.1]);

title(' Tranverse Wave Propagated t = T + 4/8T')

% Transverse wave at 5/8T

y\_at\_58 = circshift(y\_padded,10);% propagate for light ; In model just do a circular shift

subplot(9,1,6)

plot(t\_sample,y\_at\_58(t\_sample+24))

axis([0 42 -1.1 1.1]);

title(' Tranverse Wave Propagated t = T + 5/8T')

% Transverse wave at 6/8T

y\_at\_68 = circshift(y\_padded,12);% propagate for light ; In model just do a circular shift

subplot(9,1,7)

plot(t\_sample,y\_at\_68(t\_sample+24))

axis([0 42 -1.1 1.1]);

title(' Tranverse Wave Propagated t = T + 6/8T')

% Transverse wave at 7/8T

y\_at\_78 = circshift(y\_padded,14);% propagate for light ; In model just do a circular shift

subplot(9,1,8)

plot(t\_sample,y\_at\_78(t\_sample+24))

axis([0 42 -1.1 1.1]);

title(' Tranverse Wave Propagated t = T + 7/8T')

% Transverse wave at 8/8T

y\_at\_88 = circshift(y\_padded,16);% propagate for light ; In model just do a circular shift

subplot(9,1,9)

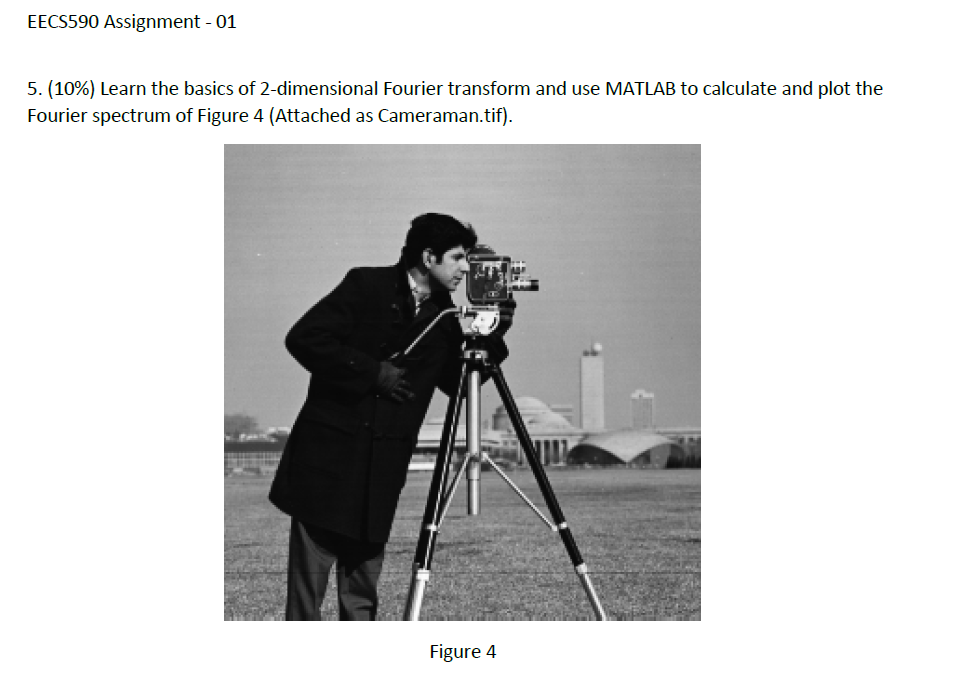
plot(t\_sample,y\_at\_88(t\_sample+24))

axis([0 42 -1.1 1.1]);

title(' Tranverse Wave Propagated t = 2T')



Problem 5



Ans :

%---------------------------------------------------------------------

% file name : hmwk\_1\_prob\_5.m

% Student: Ray Duran

% Date: 9/9/21

% Class : EECS 590 Professor Liang, Fall Semester

% University of North Dakota

% Descr: 2D FFT of Camerman

%---------------------------------------------------------------------

X = imread('cameraman.tif');

debug = 1;

sizeX = size(X,1);

sizeY = size(X,2);

% Setup Figure

lims = [ -256 256];

clim = [ 0 2000];

figure(1), clf

plot(1)

imageh = imagesc(zeros(sizeX));

axis square, axis off, axis xy

set(gca,'xlim',[lims(2)-30 lims(2)+30],'ylim',[lims(2)-30 lims(2)+30],'clim',[clim(1) clim(2)])

title('Amplitude Spectrum')

% 2-D FFT

img = abs(fftshift(fft2(X)));

set(imageh,'CData',img);

debug = 1;

Adjust picture and then create figure with this code:

function createfigure(cdata1)

%CREATEFIGURE(cdata1)

% CDATA1: image cdata

% Auto-generated by MATLAB on 11-Sep-2021 18:42:32

% Create figure

figure1 = figure;

% Create axes

axes1 = axes('Parent',figure1);

axis off

hold(axes1,'on');

% Create image

image(cdata1,'Parent',axes1,'CDataMapping','scaled');

% Create title

title('Amplitude Spectrum');

% Uncomment the following line to preserve the X-limits of the axes

% xlim(axes1,[0.5 256.5]);

% Uncomment the following line to preserve the Y-limits of the axes

% ylim(axes1,[0.5 256.5]);

box(axes1,'on');

axis(axes1,'square');

% Set the remaining axes properties

set(axes1,'CLim',[0 2000],'Layer','top');

% Create colorbar

colorbar(axes1);

Results:



Figure X

Analysis:

This is a 2-D FFT which means **before** a shift that centers everything that a 1-D FFT is applied to the columns resulting in a low frequency at the top of figure up to 2\*Pi high frequency at the bottom. Then a 1-D FFT is applied along the rows with the left side of the figure at dc and the right side again at the sampling frequency. A FFTshift moves the low frequency to the center. So, this is a natural image which means that most of the energy is at the low frequencies as is shown by figure X.

As a sanity, we can run a 2-D wavelet, which instead of using a basis of cosine and sines uses a mother wavelet expressing the image in time and frequency. What the addition of the wavelet shows us(figure Y) in addition to the 2-D FFT is how much energy is at the lowest frequency , but that there is still energy at the highest frequencies(edges) that you can see in the wavelet level 1 and in the corners of the 2-D FFT plot.

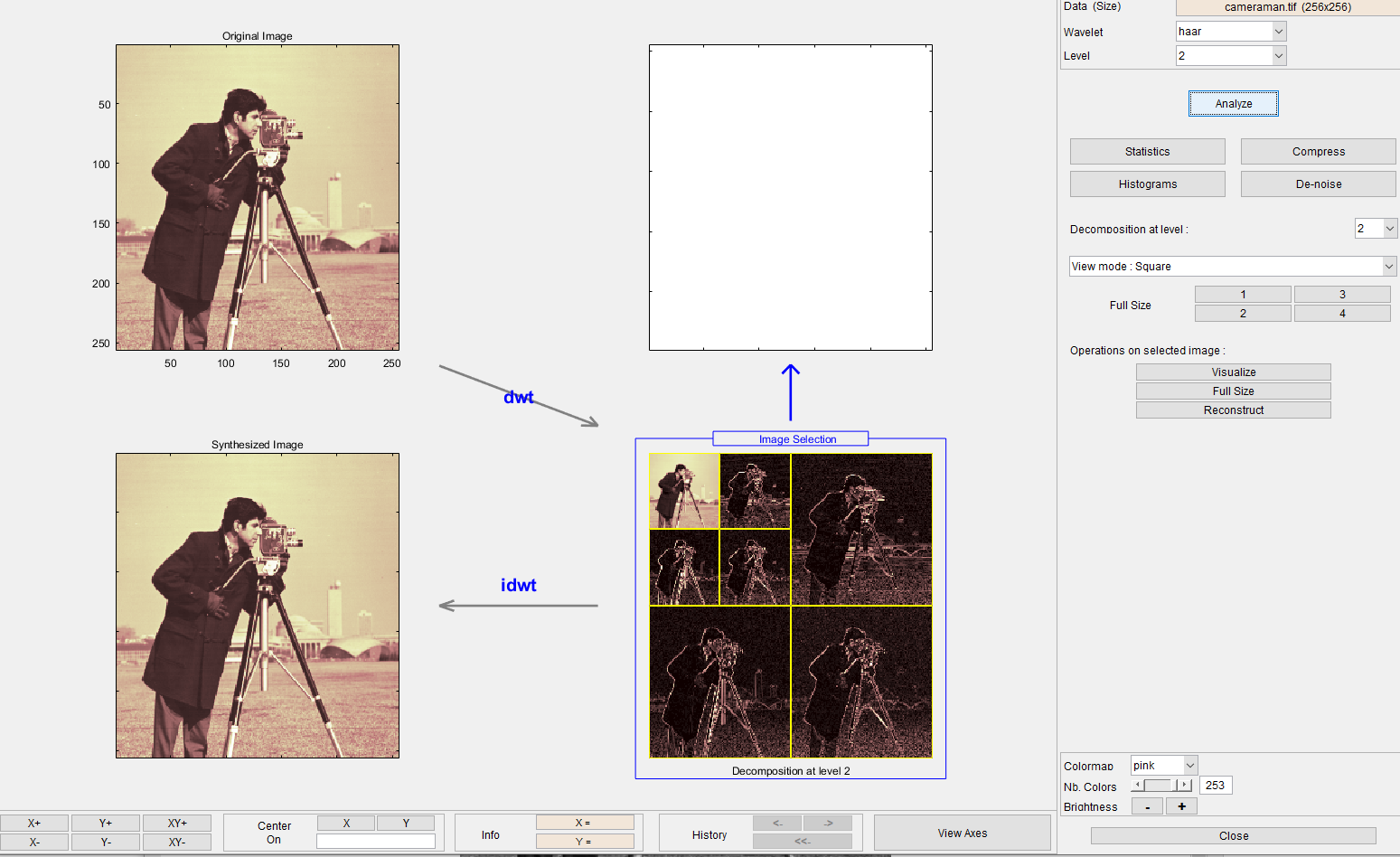


Figure Y.

All Matlab code at: <https://github.com/mathFPGAseek/und_eecs590_F21>