ECE-2026 Lab #4 Fall-2023
LAB COMPLETION REPORT

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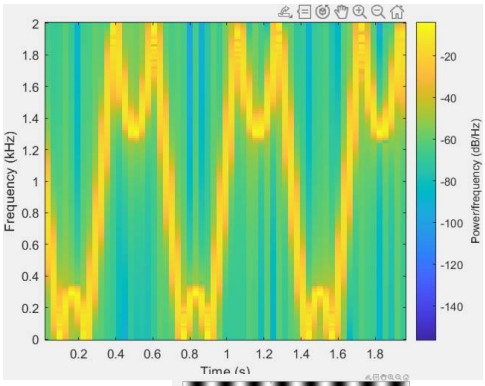
Part 1a: Did you attend the lab in week 1? Yes

Part 1b: Did you attend the lab in week 2? Yes

Part 2: Did you get full check-offs for in-lab demo? Yes

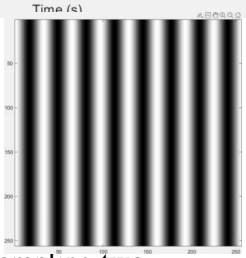
Part	Observe **and Justify**
3.1(a)	The Nyquist rate for sampling with no aliasing is $f_s =$ 24
3.1(b)	Within the $[-\pi, \pi]$ interval, $\hat{\omega} = \pm$ 0.8pi
3.1(c)	Complex amp at positive $\hat{\omega}$. e^-jpi/3
3.1(d)	Within the $[-\pi, \pi]$ interval, $\hat{\omega} = \pm$ 0.4pi
3.1(e)	Complex amp at positive $\hat{\omega}$. e^-jpi/4
3.1(f)	Three input frequencies and phases. 2Hz, 3pi/4; 42Hz, 3pi/4; 38Hz, -3pi/4
3.1(g)	Determine f_s to get a specific output frequency and phase. 16 Hz
3.2	Sketch spectrogram below. Explain.

Since the sampling rate is 4000Hz, the max value before aliasing occurs is fs/2 = 2000Hz. As shown in the spectrogram, any value above 2000Hz folds.



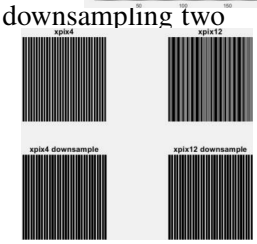
Part 3.3(a,b) Show the generated image and explain how to control the number of bands. grayscale, i.e., which values correspond to black, white, or gray.

- Since 256/32 = 8, we can observe 8 bands, by changing '32', we can get a different number of bands so 8 bands
- For all the values of 1 we get white bands (1+1 /2 = 1) and -1 we get black bands (-1 + 1 / 2 = 0) all other values are the grey areas in between.
- Since cos values are between 1 and -1, we change the scale to suit that



Part 3.4(b) Generate two test images with bands. Show those images and explain how downsampling two different images can give the same result.

Due to aliasing and folding, even though the input images were different, the downsampling resulted in the same images.



Part 3.5 Show the image and describe the aliasing effects you have observed in the image of your choice.

Whenever the color values are above half of the sampling rate, aliasing occurs and the new image is unclear. The water droplets are unclear while the stem is still the same as the older picture.

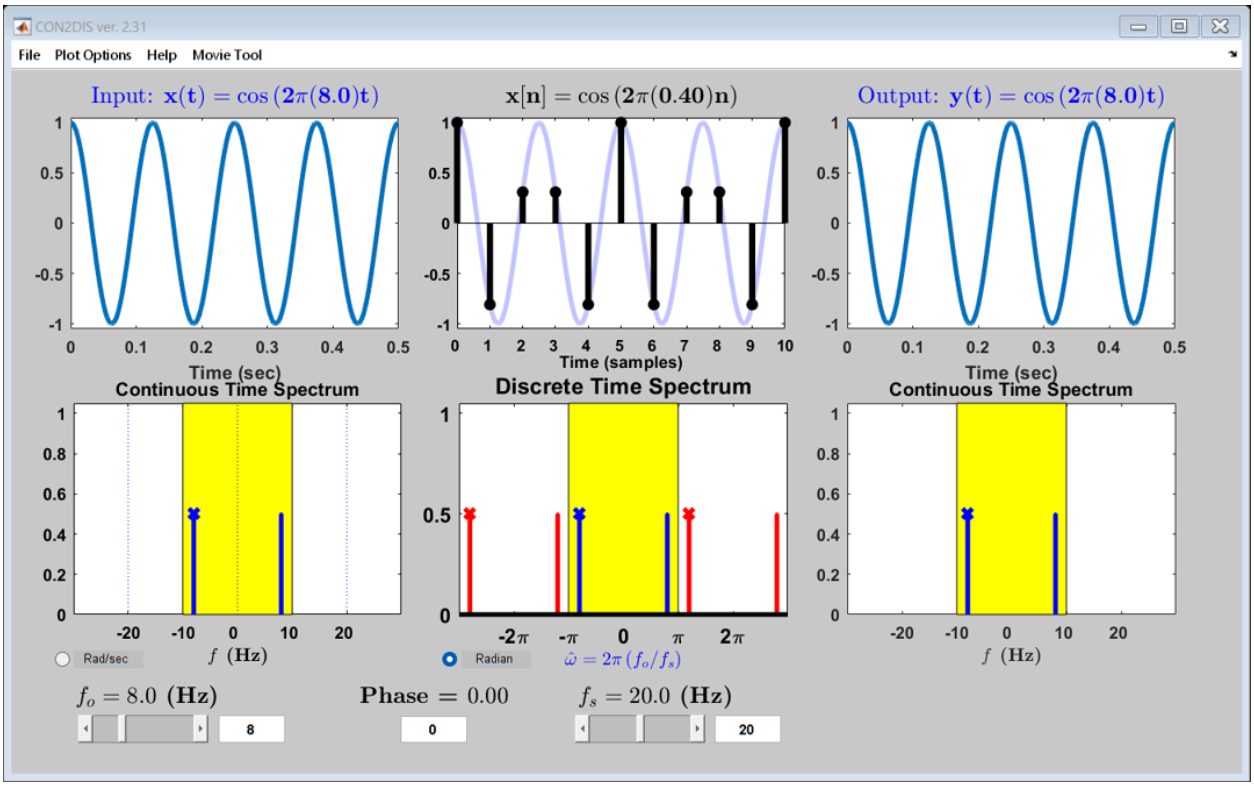
Table of Contents


```
%%Lab 4
```

3.1

```
con2dis
```

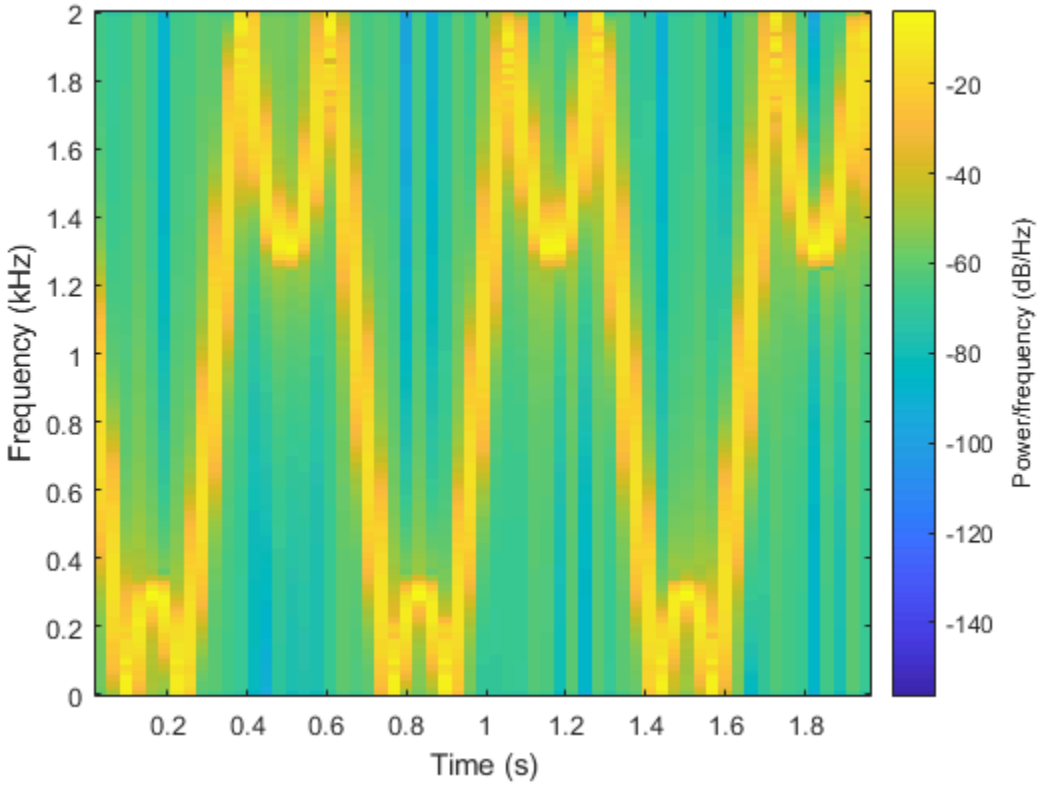
```
% Only include a screenshot for (a)
% Work out all the problems on paper
% Then you can use con2dis to verify your answers
```



3.2

```
clc;clear;close all
```

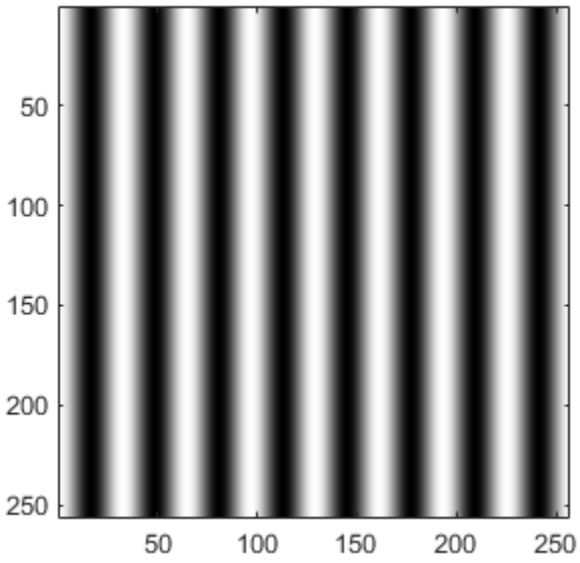
```
A=5;
fc = 1200;
alpha = 1000;
beta = 1.5;
gamma = 0;

fs = 4000;
tstart = 0;
dur = 2;

% Your code: Generate the signal
tt=0:(1/fs):dur;
xx = A*cos(2*pi*fc*tt+alpha*cos(2*pi*beta*tt+gamma));

% Your code: plot spectrogram
spectrogram(xx,256,[ ],[ ],fs,'yaxis');
```



3.3

```
clc;clear;close all

xpix = ones(256,1)*cos(2*pi*(0:255)/32);

% Your code: show the image
show_img((xpix + 1 )/2);
```

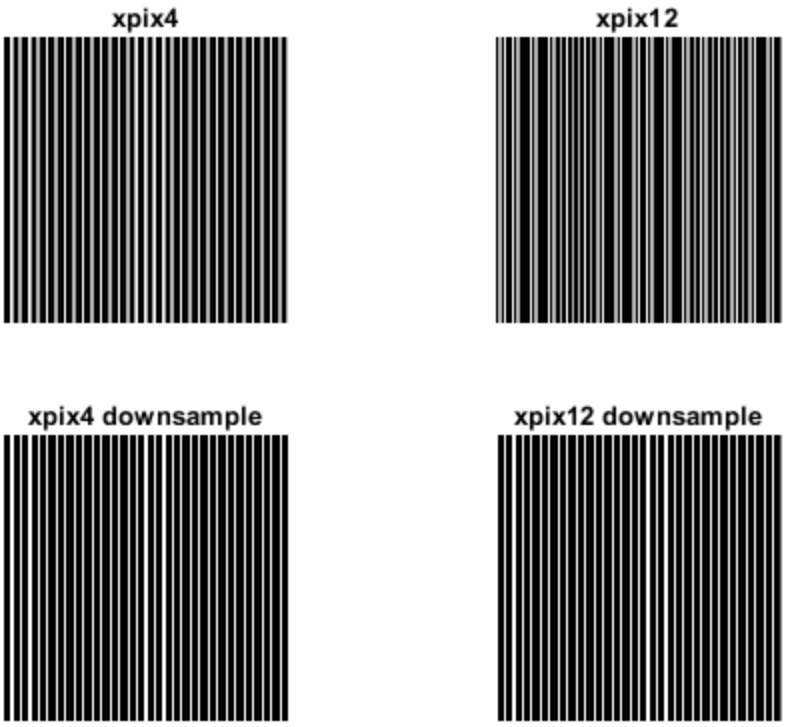
Image being scaled so that min value is 0 and max value is 255



3.4

```
clc;clear;close all

wd = 2*pi*1/32; xpix = ones(256,1)*cos(wd*(0:255));

% Your code: Generate xpix4 and xpix12
xpix4 = ones(256,1)*cos(wd*4*(0:255));
xpix12 = ones(256,1)*cos(wd*12*(0:255));

% Downsampling images
xpix4_downsample = xpix4(1:2:end,1:2:end);
xpix12_downsample = xpix12(1:2:end,1:2:end);

% Your code: Show the 2 images and the 2 downsampled images

subplot(2,2,1)
imshow(xpix4)
title('xpix4')

subplot(2,2,2)
imshow(xpix12)
title('xpix12')

subplot(2,2,3)
imshow(xpix4_downsample)
title('xpix4 downsample')

subplot(2,2,4)
imshow(xpix12_downsample)
```

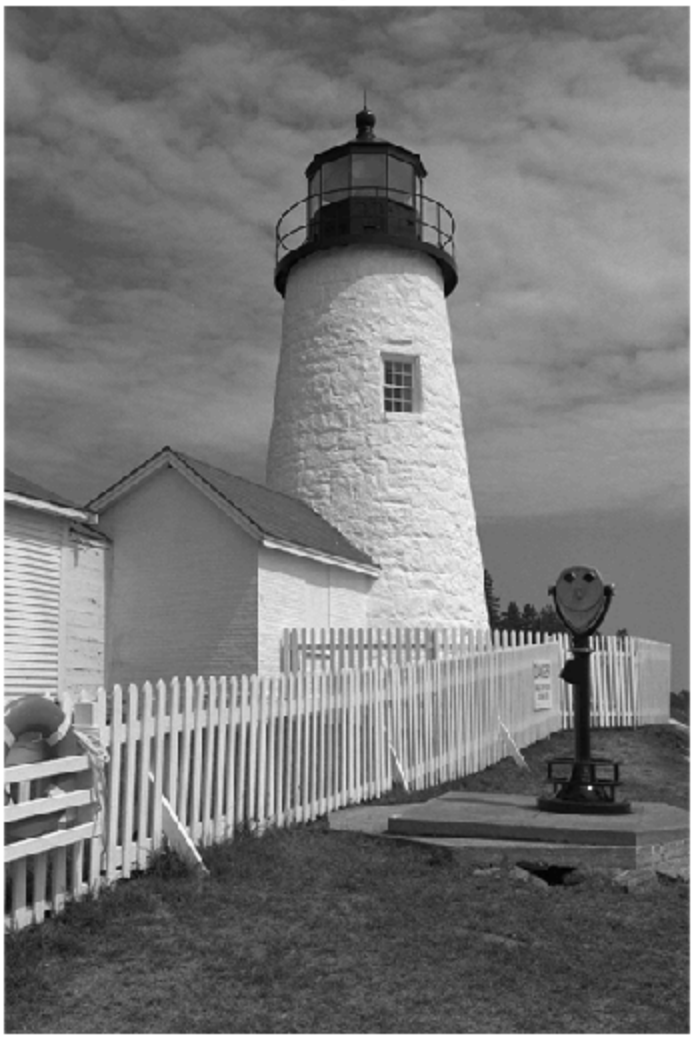
```
title('xpix12 downsample')
```



3.5

```
clc;clear;close all

img = imread('lighthouse.png');

% Downsample by 2
img_downsampled =  img(1:2:end,1:2:end);
% Your code: What's the size of the downsampled image?
% 321x214

% show the images using imshow()
figure; imshow(img); title('Original')
figure; imshow(img_downsampled); title('Downsampled')
```

Original



Your example

```
img2 = imread("grayscale.png");

img_downsampled2 = img2(1:3:end,1:3:end);

figure; imshow(img2); title('Original')
figure; imshow(img_downsampled2); title('Downsampled')
```

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