Question	# of Points Possible	# of Points Obtained	Grader
# 1	22		
# 2	30		
# 3	26		
# 4	22		
Total	100		

Include your MATLAB work along with your answers in `exam02_prob.m`. Do not change the name of the given files or functions. When complete, select all files and zip them into a folder named "exam2_UFID.zip" where UFID is your eight digit UFID number and N is the homework assignment. Ensure the files are zipped directly. Do not put them in a folder then zip that folder. Submit the resulting zipped folder to canvas.

Before starting the exam, read and sign the following agreement. By signing this agreement, I agree to solve the problems of this exam while adhering to the policies and guidelines of the University of Florida and EEL 4750 / EEE 5502 and without additional external help. The guidelines include, but are not limited to,

- The University of Florida honor pledge: "On my honor, I have neither given nor received unauthorized aid in doing this assignment."
- No collaboration is allowed
- No cheating is allowed

______________________________ ______________________________
Student Date

General Instructions
Provided is a template script `exam02.m` with useful functions. For each question, there is an associated obfuscated MATLAB function (files with a `.p` extension):

```
output = exam02_q#(UFID)
```

where the input `UFID` should be your UFID as a **string**. *Make sure this is correct.*
Tips for the Take-Home Exam

- To grade your solution, your script will be run individually and checked.
- Make sure the script runs from beginning to end without an error (otherwise, we get nothing).
- Make sure your workspace is clear before running the code.
- Your answers should be in the workspace when the script ends (this is when we extract your answers). Do not clear variables mid-way thru the script.
- For string answers, give the *exact* string shown in the options.
- Make sure your answers are in the *correct units*

Question #1: For this question, the function

```
[Ta, wb, Hb, Lb, hc, wc] = exam02_q1(UFID);
```

outputs filter parameters. Answer the following questions.

(a) *(7 pts)* Design the `a` and `b` filter coefficients for filter that approximates (using sampling period `Ta`) the derivative operation $H(s) = s$.

(b) *(7 pts)* The function generates a frequency magnitude response `Hb` with cooresponding angular frequencies `wb`. Design the impulse response for an FIR filter that approximates this plot. The filter should be of length `Lb` and linear phase.

(c) *(8 pts)* The vector `hc` represents filter coefficients of a low pass filter. Transform the filter into a bandpass filter around normalized (DTFT) center angular frequency `wc`.

Question #2: For this question, the function

```
[n2, x2, x2mod, fs2, fs2new] = exam02_q2(UFID);
```

provides an audio signal `x` (or $x[n]$) with respective time axes n_x and sampling rate `fs`.

(a) *(4 pts)* Compute the discrete Fourier transform (DFT) of `x2` with time indices `n2` [1].

(b) *(4 pts)* Compute the indices k corresponding to the DFT.

(c) *(4 pts)* Determine the corresponding DTFT frequencies ω_k [in radians/s].

(d) *(4 pts)* Determine the corresponding CTFT frequencies f_k [in Hz] with sampling rate `fs2`.

(e) *(4 pts)* The variable `x2mod` is an upsampled or downsampled version of `x2`. Identify which operation occur

(f) *(4 pts)* Identify the corresponding upsampling or downsampling factor from part (a).

(g) *(6 pts)* Resample the signal `x` to have new sampling rate `fsnew`. Ensure no aliasing occurs. If filtering the data, try not to overly distort the signal.

[1]Note: They are standard time indices.

Question #3: For this question, the function

```
[x3, s3, fs3] = exam02_q3(UFID);
```

outputs the mock received RADAR-like signal `x3`, the corresponding transmitted signal `s3`, and its associated sampling rate `fs3`. In theory, RADAR relatively simple. We transmit a radio signal into the air and listen/receive reflections from aircrafts. A simple single antenna RADAR system is interested in two quantities: (1) the aircraft's range (i.e., distance from the RADAR) and (2) the aircraft's speed. The range corresponds to the time it takes for a signal to travel to the aircraft and back. The speed corresponds to a shift in frequency due to the Doppler effect.

(a) *(5 pts)* Identify the length of `x3`, in seconds.

(b) *(7 pts)* Identify N, the number of reflections (i.e., aircrafts) discovered in `x3`.

(c) *(7 pts)* For each of the N reflections, determine its shift in time (in seconds). This would correspond to the aircraft distance. [2]

(d) *(7 pts)* For each of the N reflections, determine its shift in frequency (in Hz). This would correspond to the aircraft speed.

Question #4: For this question, the function

```
[M,G,V,fs4] = exam02_q4(UFID);
```

Consider the standard filter bank with M branches, each with a downsampling rate of M. The variable `G` is a matrix of FIR analysis filters that satisfy the orthogonal filter bank conditions (each column is a single impulse response). The value of `V` represents the output of the analysis bank.

(a) *(8 pts)* Build a synthesis bank and reconstruct the original data (has sampling rate of `fs4`).

(b) *(5 pts)* The values of V contains some noise. Reconstruct the original data without noise[3].

(c) *(5 pts)* The values of V are slowed down by 2 times. Reconstruct the original data without the speed increase (keep the noise).

(d) *(4 pts)* Reconstruct the original data without the speed increase and noise reduction.

[2] Reminder: You do not need an automated algorithm to solve – answer can be found from plotting

[3] Note: I have rigged this to be much easier than would be normal