BLG 354E Homework - 4

Due Date: 03.06.2018 23:59

- Cheating is highly discouraged. It could mean a zero or negative grade. Please do your homework on your own. Team work is not allowed. Pattern of your solutions must be belong to only you.
- Prepare reports using LaTeX. Otherwise, you will get 0 point.
- After the deadline, your point will decrease with slope -10 according to the number of days past.
- Upload your solutions with code files through Ninova (Do not forget to upload code files separately.).
- There will be no postponement on the due date.
- If you see any mistake in the homework, inform me as soon as possible.

For your questions: albay@itu.edu.tr

1. You must implement a single channel AM communication system Fig. 1.

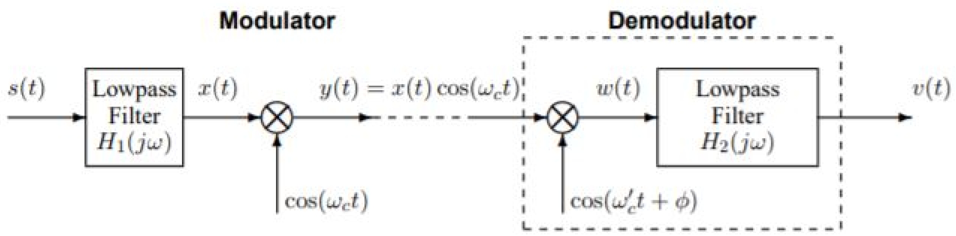

Figure 1: Block diagram of sinusoidal modulation followed by demodulation with variable phase.

Since you will be simulating this system with Python 3.5+, the signal $s(t)$ will be sampled, the filters and modulators will be discrete-time systems, and the output $v(t)$ will be the output of your computer's D/A converter. Here are the step:

(a) Make an input signal by recording your voice for a one or two seconds. Use a sampling rate of 44.1 kHz. The best test signal would have lots of vowels. Plot the waveform using plot. Determine the beginning and end of significant speech activity and select only that region for processing.

(b) Filter the voice signal with the given FIR lowpass filter. Compute the frequency response of the filter whose coefficients (You can use scipy.signal.freqz).

(c) Display the spectrogram of your filtered voice and estimate the bandwidth of the speech signal.

(d) Make an AM signal by multiplying your voice by a cosine. Use a "carrier frequency" $f_c = \omega_c/2\pi$ that is between 8 kHz and 9 kHz.

(e) Simulate the demodulator for the AM signal. Write the demodulator as a function with input arguments for the frequency and phase. In other words, implement a demodulator that can have a different carrier frequency $f_c' = \omega_c/(2\pi)$ and non-zero phase ϕ.

(f) First experiment with the effect of the phase difference. Set the demodulator carrier frequency exactly equal to the modulator carrier frequency. You can hear the effect of phase if you normalize your input signal $s(t)$ so that its maximum magnitude is 1. Then you can listen to the various signals. Demonstrate how the demodulator output depends on the phase. Show that for one choice of the phase that you get zero output.

(g) Next set the phase to zero and make the demodulator carrier frequency 10 Hz higher than the carrier frequency of the modulator. Listen to the demodulated signal. How do you characterize the output?