ECE240:PCS

Assignment #1(CO3)

Instructor: *o*

ing assignments are considered for evaluation if they are submitted as a report alongside the code. Any clarification can be provided as comments or snippets of mathematical derivations in your report. Assignment to be turned in before the time mentioned above. Unless mentioned, you are not allowed to use any inbuilt functions. If you are planning to code in Python, please replace the word Matlab by Python.

For the below questions use the following audio file: Record your voice where you state your roll number. Store it as a *.wav file (or any other format that Matlab may read). The name of the file must be NameRollNumber.wav.

- Question: How does noise and phase effect the transmission and recovery of an amplitude modulated real-world audio signal? To answer this question, implement the following:
  - Apply Amplitude modulation on the signal using $f_c = 2000Hz$. Verify and analyze by providing plots that the resulting signal is indeed passband by plotting the FFT (use inbuilt function) of the modulated signal.
  - Add noise with signal to noise ratio of 10dB. Use the command `awgn()`, which takes the AM signal and SNR as the input. Do envelope detection on the noisy AM signal using the commands `abs(hilbert(.))` whose input is the noisy AM signal followed by a low-pass filter to remove high-frequency components. Low pass filter needs to be implemented using `butter(.)` and `filter(.)` command. Provide plots of the detected analog signal with and without noise and compare. Detailed experimental analysis needs to be provided by plotting the FFT (use inbuilt function) of the demodulated signal with and without noise.
  - Generate a nonlinearity distorted AM signal as $s'(t) = s(t) + 0.2s^3(t) - 0.05\ s^5(t)$, where $s(t)$ is the original AM signal. Plot the FFT of the distorted signal. Demodulate the signal similar to the previous question. Perform detailed analysis (all experimental) on the demodulated signal and discuss the effect of distortion.
  - For this question, use synchronous demodulation. Introduce a phase mismatch in the local oscillator used for demodulation. Repeat the experiments for values of phase as $[\pi/6, \pi/3, \pi/2]$. Compute the output of the synchronous demodulator and plot the difference between the true message signal and decoded message signal. Play the true signal and the demodulated signal and see if the phase error can be detected.
- Question: How does noise and phase effect the transmission and recovery of an amplitude modulated real-world audio signal? To answer this question, implement the following:
  - Generate an FM signal with $f_c = 2000Hz$ and $k_f = 50$. Plot the FM signal as a function of time.
  - Pass the FM signal through a non-linearity same as the previous question. Plot the distorted FM signal as a function of time.
  - Demodulate the distorted FM signal by extracting the instantaneous frequency of the FM signal using a differentiator followed by an envelope detector.
  - Play the true signal and the demodulated signal and see if the effect of non-linearity can be perceived by the ear.