1.

Write a MATLAB program to speed up a speech file by a factor of 2-to-1. Use the method of overlap-add to analyze the STFT of the signal (using a rectangular window of length 512 samples with 256 sample overlap between frames), throw out every other frame, and re-synthesize the speeded-up speech. Plot the original speech file and the speeded up speech file, and plot the narrow band spectrograms of both the original and the speeded up speech files. Use the speech file *test_16k.wav* to test your program.

2.

Write a MATLAB program to compute the real cepstrum of a speech file and lifter the cepstrum using both a low quefrency lifter and a high quefrency lifter to illustrate the differences in retrieving a representation of the vocal tract response (the low quefrency lifter) or the source excitation (the high quefrency lifter). Use the speech file *test_16k.wav* with a voiced frame beginning at sample 13,000 (of duration 40 msec) and an unvoiced frame beginning at sample 1000 (again of duration 40 msec). Use a Hamming window to isolate the frame of speech being processed. For both the voiced and unvoiced frames, plot the following quantities:

1. The Hamming window weighted speech section (make sure that you window length of 40 msec reflects the correct number of samples, based on the sampling rate of the speech signal)
2. The log magnitude spectrum of the signal with the cepstrally smoothed log magnitude spectrum (in the case of a low quefrency lifter)
3. The real cepstrum of the speech signal
4. The liftered log magnitude spectrum (for both low quefrency and high quefrency liftering operations)

Make plots for both voiced and unvoiced sections of speech, and for both the low and high quefrency lifters. Your program should accept the following inputs:

- The speech file being processed
- The starting sample for the speech frame being processed
- The duration of the speech frame (in msec) which must be converted to a frame duration in samples, based on the speech sampling rate
- The size of FFT used in cepstral computation
- The cutoff point of the cepstral lifter (either the high cutoff for a low quefrency lifter, or the low cutoff for a high quefrency lifter)
- The type of lifter (low quefrency or high quefrency)

3.

Write a MATLAB program to compute the optimal set of linear prediction coefficients from a frame of speech using the autocorrelation LPC analysis method. To test your program, use a frame of steady vowel and a frame of a fricative sound. Hence for each test example, you should input the following:

- Speech filename: *ah.wav* for the voiced test frame, *test_16k.wav* for the unvoiced test frame

- Starting sample of frame: 3000 for both the voiced and unvoiced test frames
- Frame length (in samples) :300 for the voiced frame (where the sampling frequency is 10kHz), 480 for the unvoiced frame (where the sampling frequency is 16kHz)
- Window type: Hamming for both frames
- LPC analysis order: 12 for both the voiced and unvoiced frames

For each of the analyzed frames, plot (on a single plot) the short-time Fourier transform log magnitude spectrum of the windowed frame of speech and the LPC log magnitude spectra from the autocorrelation LPC analysis method.