HKUSTx: ELEC1200.2x A System View of Communications: From Signals to...

LAB 4 - TASK 2 (1 point possible)

In this task, we will implement the demodulation process.

```
subplot(2,1,2)
zoom_start =200000;
zoom_stop =210001;
ind = zoom_start:zoom_stop;
plot(t(ind),rxa(ind),'r'); hold on;
plot(t(ind),x(ind),'--b'); hold off;
legend('Original message','Recovered message');
xlabel('Time(sec)')
ylabel('Amplitude')
title(['Original and recovered messages (zoom in view)']);
axis([t(zoom_start) t(zoom_stop) -0.4 0.4]);
grid;

% figure 1 on top
figure(1);

```

Unanswered

Figure 1

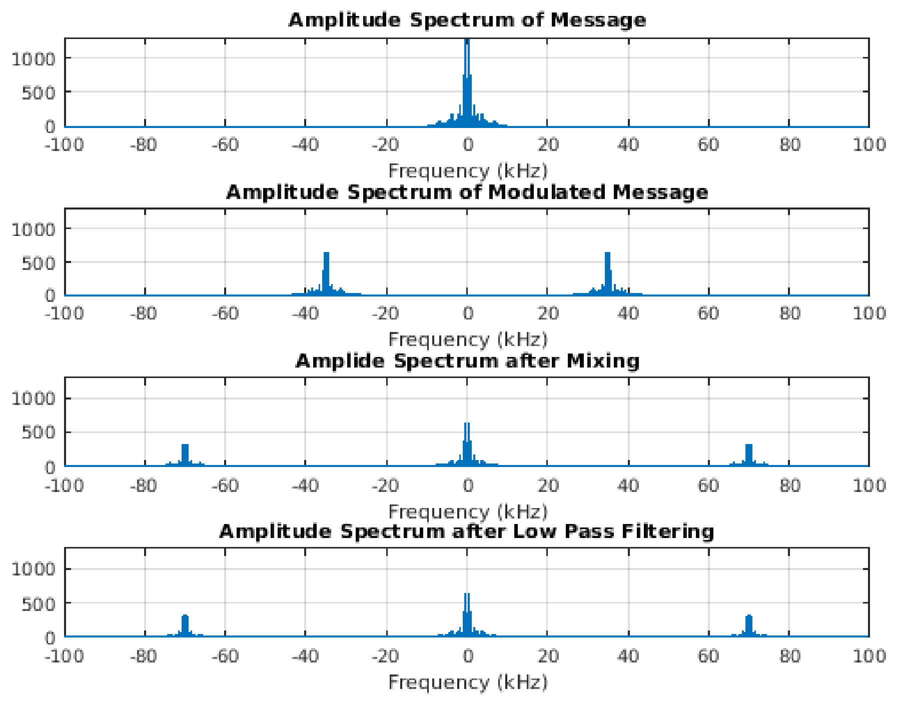
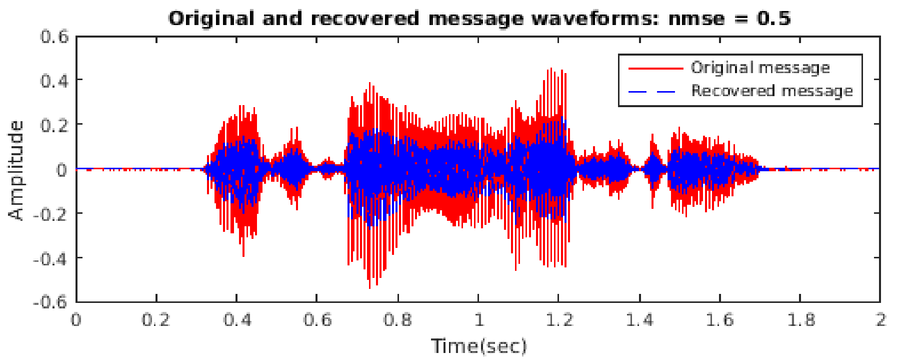
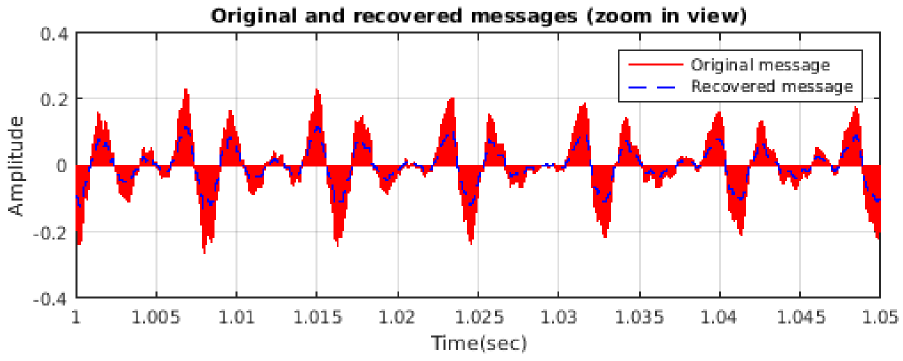


Figure 2





```
200000
```

Run Code

INSTRUCTIONS

The MATLAB code in the above window shows an example of amplitude modulation and demodulation. The initial code first loads a speech signal **x**, which was acquired with sampling frequency **Fs**. Then, it computes the duration of the signal (**Tmax**), the sample period (**Ts=1/Fs**) and a vector of sample times (**t**). We modulate a carrier by the speech signal using the function **modulate.** Then, we send the modulated signal (**tx_wave**) through the channel and receive the new signal **rx_wave**. As in the previous task, we have an ideal channel, so that **tx_wave=rx_wave**. Then, we start the demodulation process, which should consist of three steps: 1) generation of a mixing signal, which should be a copy of the carrier, i.e. a cosinusoidal wave with frequency equal to **freq_carrier,** and with length equal to the length of the received signal **rx_wave** 2) multipling the received signal **rx_wave** by the mixing signal, and 3) removing high frequency components introduced by mixing by using a low pass filter. In the demodulation process, there are some mistakes and your task is to fix them. In order to do this, you also need to figure out the frequency used for modulation.

If you run the initial code, it will generate two figures. In Figure 1, there are four subplots that show the amplitude spectrum of the message (**x**), of the modulated signal (**tx_wave)** and the mixed signal before (**xd**) and after (**rx**) the lowpass filter, respectively. The second subplot, showing the amplitude spectrum of the modulated signal, is useful for estimating the frequency of the carrier wave used by the modulator, which is different from the one used in Task 1. In the third subplot you can note that the demodulated signal is equal to the modulated one. If you correct the code, you will see a copy of the amplitude spectrum of the message centered at zero frequency and with half the amplitude, and two copies with one quarter the amplitude centered at twice the carrier frequency. Finally, by choosing the cut-off frequency of the low pass filter correctly, you will remove these two copies at high frequencies, leaving just the signal in the center of the spectrum.

Figure 2 shows two subplots that are used to compare the original message (**x**) and the recreated message (**rx**). As in task 1, in order to compare the two signals, we double the amplitude of the received signal. In the first subplot, we show the entire signal in the time domain, while in subplot 2 we zoom into the previous plot and show the signals in the time interval between 1 and 1.05 seconds. Due to the mistakes in the code, the recreated message is different from the original one. Indeed, the **nmse** is equal to 3. If you correct the code the **nmse** should be around 5e-8.

Your task is to correct the mistakes in the demodulation process and store the demodulated signal inside the variable **rx**. In particular, note that in this task we do not know the frequency used to modulate the signal, so that we need to estimate that by visually inspecting the modulated signal [Fig. 1(2)], and further refining this estimate by examination of the demodulated signals. Please, revise the code between the lines

% % % % Revise the following code % % % %

and

% % % % Do not change the code below % % % %

and do not change other parts of the code.