LAB 4 - TASK 1 (1/1 point)

In this task, you will learn how to modulate a carrier wave by a message signal.

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

% figure 1 on top
figure(1);



```

Correct

Figure 1

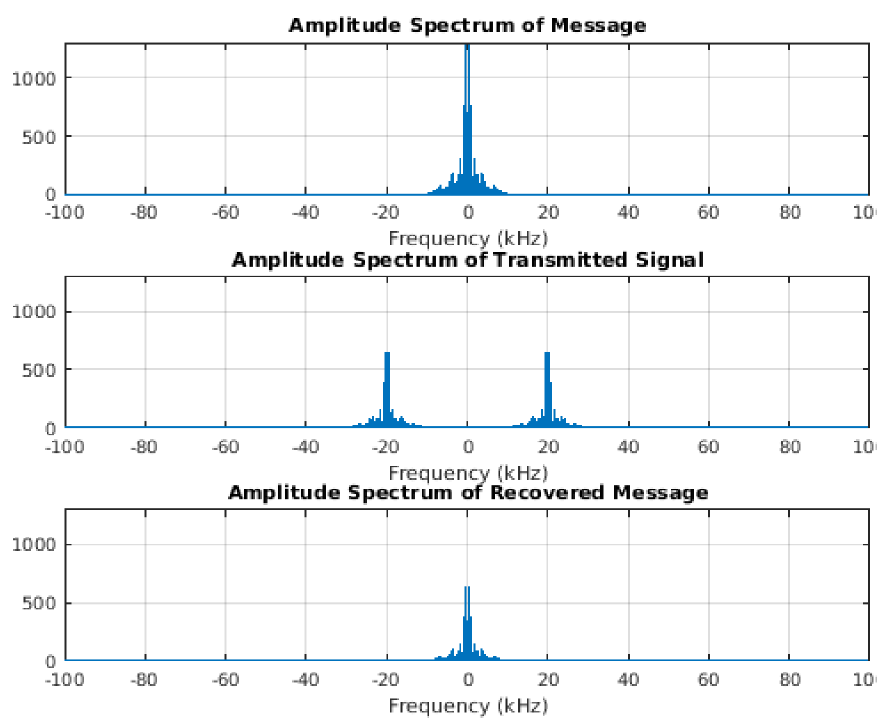
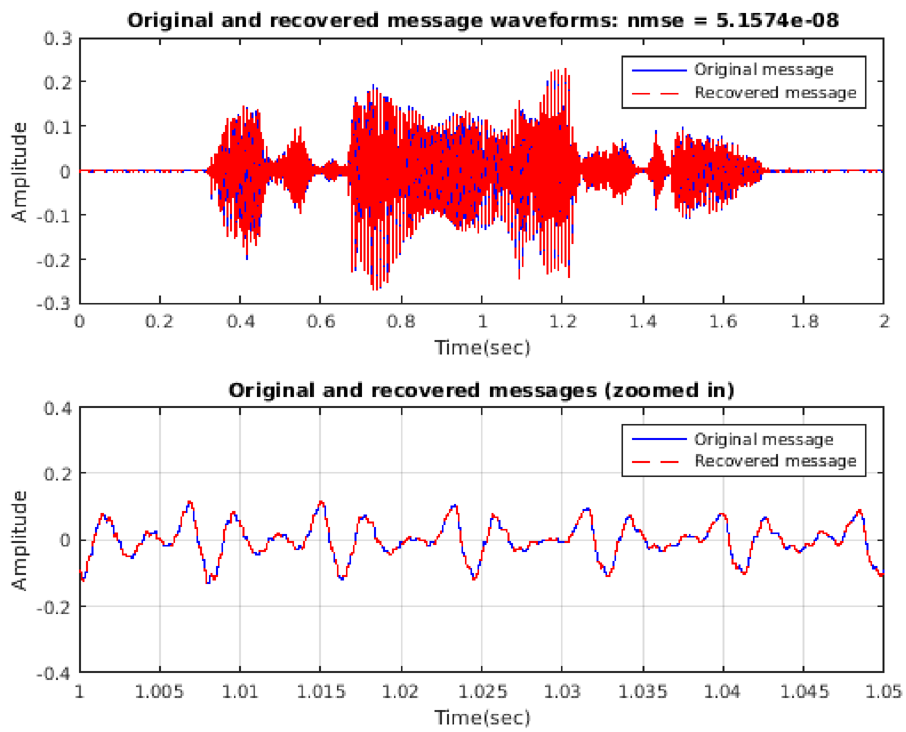


Figure 2



You have used 1 of 10 submissions

INSTRUCTIONS

The MATLAB code in the above window shows an example of amplitude modulation and demodulation. In the initial code, we first load a speech signal **x**, which was acquired with the sampling frequency **Fs**. Then, we compute the duration of the signal (**Tmax**), the sampling period (**Ts=1/Fs**) and a vector of sample times (**t**). Then we set the frequency of the carrier wave (**freq_carrier**) to 20KHz and we start the modulation process. In the modulation process there are some mistakes and your task is to correct them. The modulation process consists of two steps: 1) generating the carrier wave **ym**, which should be a cosinusoidal wave with frequency equal to **freq_carrier**, and 2) multiplying the message **x** by the carrier wave. Then, we send the modulated signal (**tx_wave**) through the channel and we will receive the signal **rx_wave**. In this example, we have an ideal channel, so that **tx_wave=rx_wave**. Finally, we demodulate the received signal using the function **demodulate** and plot some signals.

If you run the initial code, it will generate two figures. In Figure 1, there are three subplots that show the amplitude spectra of the message (**x**), of the modulated signal (**tx_wave**) and of the received message (**rx**), respectively. The amplitude spectrum of the message is symmetric and it has some high peaks around +-250 Hz (you can see them by replotting subplot 1 over a smaller range or zooming in on the plot if you run MATLAB on your own computer). Also, the amplitude spectrum is zero for frequencies higher than 10 KHz, which is the bandwidth of the message. Due to an error in the code, the amplitude spectrum of the modulated signal is the same as the spectrum of the message (subplot 2). If you correct the errors, you will see two copies of the original amplitude spectrum centered around **freq_carrier** and **-freq_carrier**, but with half the amplitude. The amplitude spectrum of the recovered message (subplot 3) should be equal to the amplitude spectrum of the transmitted message multiplied by one half. Now it is zero due to the mistakes in the code.

Figure 2 shows two subplots that are used to compare the original message (**x**) and the recovered message (**rx**). In order to compare the signals we double the amplitude of the recovered signal. In the first subplot, we show the entire signals in the time domain, while in the subplot 2 we zoom into the previous plot and show the signals in the time interval between 1 and 1.050 sec. Due to the mistakes in the code, the recreated message is different from the original one. Indeed, the normalized mean squared error (nmse) is equal to 1. If you correct the code the **nmse** should be around 5e-8.

Your task is to correct the mistakes in the modulation process. Be sure that the modulated signal is stored in the variable **tx_wave**. Please, revise the code between the lines

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

and

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

Do not change other parts of the code. Also, do not use the function **modulate**.