LAB 5 - TASK 3

In task 3, you will investigate the effect of phase mismatch between the carriers used by the transmitter and the receiver in the QPSK modulation scheme.

```
% initalization
Fs=1e6;                 %sampling frequency
Fc=1e5;                 %carrier frequency for message 1
Fcutoff=25e3;           %cutoff frequency of low pass filter
SPB=20;                 % samples per bit
Ts=1/Fs;                % sample period

textmsg1 = sprintf('%s\n%s\n%s',...
    'It was the best of times, it was the worst of times',...
    'it was the age of wisdom, it was the age of foolishness,',...
    'it was the epoch of belief,');
textmsg2 = sprintf('%s\n%s\n%s',...
    'Lorem ipsum dolor sit amet, at vivamus erat lectus a augue,',...
    'eget a diam aliquam consectetuer, vivamus ad wisi hac posuere',...
    'praesent tincidunt vel.');

```

Correct

```
wave_r1 = rx_wave.*cos(2*pi*Fc*t + phase_shift);
wave_r1 = lowpass(wave_r1, Fs,Fcutoff);
msg_r1 = waveform2text(wave_r1,SPB);

wave_r2 = rx_wave.*sin(2*pi*Fc*t + phase_shift);
wave_r2 = lowpass(wave_r2, Fs,Fcutoff);
msg_r2 = waveform2text(wave_r2,SPB);
```

Original Message 1:
It was the best of times, it was the worst of times
it was the age of wisdom, it was the age of foolishness,
it was the epoch of belief,
Recovered Message 1:
It was the best of times, it was the worst of times
it was the age of wisdom, it was the age of foolishness,
it was the epoch of belief,
Num of Bit-Error: 0

Original Message 2:

Lorem ipsum dolor sit amet, at vivamus erat lectus a augue,
eget a diam aliquam consectetuer, vivamus ad wisi hac posuere,
praesent tincidunt vel.
Recovered Message 2:
Lorem ipsum dolor sit amet, at vivamus erat lectus a augue,
eget a diam aliquam consectetuer, vivamus ad wisi hac posuere,
praesent tincidunt vel.
Num of Bit-Error: 0

INSTRUCTIONS

Our implementation of QPSK have so far assumed that the carriers used for modulation and demodulation at the transmitter and receiver have exactly the same phase. However, since the transmitter and receiver are separate entities, the carriers may have different phases. In particular, the phase shift may vary as the characteristics of the channel change. An important part of a receiver, which we have not discussed, are components to ensure the carrier used to demodulate the signal has the same phase as the transmitter. However, in this task, we will examine the effect of phase mismatches in order to see why it is so important to match the transmitter and receiver phase.

The MATLAB code in the above window is similar to the code in the previous task. We have two messages, transmitted by using **QPSK** modulation with the carrier frequency set to **Fc**. However, in the initial code, there is some error in the implementation of the receiver between the lines

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

and

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

Your first task is to correct these mistakes in order to implement QPSK correctly. To do that, use the code that you implemented in Task 2 as reference. Once your code runs correctly, try to change the value of the variable **phase_shift**, which changes the phase of the carrier used to demodulate the signal, and observe how it affects the recovered messages. Use the insight gained to answer the questions below.

LAB 5 - TASK 3 QUESTION 1 (1/1 point)

What happens if the phase shift is equal to $\pi/2$? Check all that apply.

- [ ] The messages at the outputs of the I and Q channels are the same as those at the corresponding inputs.
- [x] The messages at the outputs of the I and Q channel are both different than those at the corresponding inputs. ✔
- [x] Message 1 is recovered as message 2. ✔
- [ ] Message 2 is recovered as message 1.

✔

You have used 1 of 2 submissions

LAB 5 - TASK 3 QUESTION 2 (1/1 point)

When the phase shift is equal to $-\pi/2$, the output of the Q channel (Recovered Message 2) appears to be garbage. Suppose that in addition we also invert the sign of **wave_r2** before passing it into **waveform2text**.

Which of the following is/are true?

- [ ] The messages at the outputs of the I and Q channels are the same as those at the corresponding inputs.
- [x] The messages at the outputs of the I and Q channel are both different than those at the corresponding inputs. ✔
- [x] Message 1 is recovered as message 2. ✔
- [x] Message 2 is recovered as message 1. ✔

✔

You have used 1 of 2 submissions

LAB 5 - TASK 3 QUESTION 3 (1/1 point)

Our mathematical analysis assumed that the carriers used for modulation and demodulation at the transmitter and receiver had exactly the same phase. However, the communication system usually still works with small mismatches between the two. For the above system and messages, how large can the mismatch be before errors are introduced?

- $\pi/32$
- $\pi/16$ ✔
- $\pi/8$
- $\pi/4$

You have used 1 of 2 submissions