EE3TR4 Lab 3 **DSBSC AND QAM : Modulation and Demodulation**

Please work individually or in pairs. Hand in one report per group. Late penalty is 10% per week.

Modify the code "dsbsc_modem.m" to do Numerical Expt #3.1.

Num. Expt. 3.1: The message signal is

$$m(t) = A_m \cos(2\pi f_m t),$$

where A_m = 1 V and f_m = 1 kHz.

The DSB-SC signal is

$$s(t) = A_c m(t) \cos(2\pi f_c t),$$

where A_c = 1V and f_c = 10 kHz. Do the following numerical experiments:

a. Plot the DSB-SC in time and frequency domains. As for frequency domain, plot the magnitude spectrum (no need to plot the phase spectrum). Identify phase reversals in the time domain plot.
b. A plot of the resulting signal, $\hat{s}(t)$, in both the time and frequency domains (no need to plot the phase spectrum), when $s(t)$ is again multiplied by the local carrier $\cos(2\pi f_c t + \theta)$ when θ=0.
c. The signal $\hat{s}(t)$ passes through a low pass filter (LPF). Choose a proper value of the cut-off frequency of the LPF so that the spectrum centered around $2f_c$ is removed. Plot the output of the LPF in time domain when (i) θ=0, (ii) $\theta = \pi/2$, and (iii) $\theta = \pi/4$. Which of these cases correspond to quadrature null effect? Explain the need for phase synchronization. Comment on the possible ranges for the cutoff frequencies of the LPFs.

Modify the code "qam_modem.m" to do Numerical Expt #3.2.

Num. Expt. 3.2.: The first message signal is

$$m_1(t) = 2\mathrm{sinc}(t/T_m),$$

$$\mathrm{sinc}(x) = \sin(\pi x)/(\pi x),$$

where T_m = 0.001 s. The second message signal is

$$m_2(t) = \mathrm{sinc}^2(t/T_m),$$

The QAM signal is

$$s(t) = A_c[m_1(t)\cos(2\pi f_c t) + m_2(t)\sin(2\pi f_c t)],$$

where A_c = 1V and f_c = 10 kHz. Do the following numerical experiments:

a. Plot the QAM signal in time and frequency domain (no need to plot the phase spectrum).
b. At the receiver, after demultiplexing and demodulating, let the signals corresponding to in-phase and quadrature carriers pass through LPFs. Choose a proper value of the cut-off frequency of the LPFs so that the spectrum centered around $2f_c$ is removed. Plot the outputs of the LPFs in time domain when (i) θ=0, and (ii) $\theta = \pi/4$.

Hints and Suggestions:

1. To identify the phase reversal, you will have to improve the time resolution. This can be done by increasing the sampling rate. As the sampling rate increases, the interval between

two samples (i.e. tstep in the code) decreases.

2. As the sampling rate increases, the simulation bandwidth (i.e. fmax in the code) increases, which lowers the frequency resolution unless you increase the number of samples. As a result, amplitude of the lower and upper sideband in the DSB-SC spectrum may look different. This is not a problem.