1. Let the message signal be

$x_{bb}(t) = 2\cos(3000\pi t) + 4\cos(2000\pi t) + 6\cos(1000\pi t)$

be input to a DSB-SC modulator at a carrier frequency of 50kHz and an unmodulated carrier amplitude of 20.

      a. Find the Fourier transform of the DSB-SC signal.

      b. Plot the spectrum of the DSB-SC signal.

      c. Identify the upper and lower sideband in the DSB-SC signal.

      d. What is the RF bandwidth?

      e. What is the total transmitted power?

2. Let the message signal be $x_{bb}(t) = 10\text{rect}(t/0.01)$ be input to a DSB-SC modulator at a carrier frequency of 40kHz and an unmodulated carrier amplitude of 5.

      a. Find the Fourier transform of the DSB-SC signal.

      b. Plot the spectrum of the DSB-SC signal.

      c. What is the RF bandwidth?

3. Let the message signal be $x_{bb}(t) = 4000\,\text{sinc}^2(10000t)$ be input to a DSB-SC modulator at a carrier frequency of 40 kHz and an unmodulated carrier amplitude of 10.

      a. Plot the spectrum of the DSB-SC signal.

      b. What is the RF bandwidth?

4. Consider a sequence of information bits b_i {....0,1,0,1,0,1,0,1....}, That is, alternating 0's and 1's. A baseband analog message signal m(t) is formed as

$$m(t) = \sum_{k=-\infty}^{\infty} d_i\, rect[\frac{t - \frac{(2k+1)\tau}{2}}{\tau})]$$

where d_i=-2 if b_i = 0 and d_i=+2 if b_i= 1

      a. With τ=1ms, plot m(t) for k=1...6.

      b. What is the DC (or average value) of m(t)?

      c. Find the Fourier Series of m(t) and plot its amplitude spectrum.

      d. DSB-SC modulation is used to transmit m(t) with a carrier wave of carrier signal

$10\cos(2\pi f_c t)$ with f_c = 20kHz. Plot the RF signal.

      e. Plot the spectrum of the DSB-SC modulated signal

      f. With τ=1ms find the average energy per bit in the modulated signal.

      g. How would the spectrum of the RF signal change with a different mapping of bits to

levels, specifically, changing d_i=-4 if b_i = 0 and d_i=+4 if b_i= 1 to d_i=0 if b_i = 0 and d_i=+4 if b_i= 1.

5. Let s(t) be an DSB-SC signal, $x_{RF}(t)= x(t)\cos(2\pi f_c t)$ with f_c=100kHz and x(t)=cos(2000πt).

      a. There is only a frequency error in the coherent detector of Δf=10Hz. Find the output of the coherent detector, y(t) and plot y(t).

      b. There is only a phase error in the coherent detector of 45^0. Find the output of the coherent detector, y(t) and plot y(t).

6. In BPSK receivers why is both carrier and bit synchronization needed?

7. A received binary signal with a bit rate of 10kb/s is with f_c=100 KHz

    1 bit then transmit $10^{-4}\cos(2\,\pi f_c t)$ $0 \le t \le T_b$

    or

    0 bit then transmit $-10^{-4}\cos(2\,\pi f_c t)$ $0 \le t \le T_b$

    a. Is this a BPSK or ASK signal?

    b. What is the bandwidth of RF signal?

    c. What is the E_b the energy/bit?

    d. Change the transmitted signal for a 0 bit to 0, that is, transmit 0 if 0 bit. and repeat a-c

8. Assume that a DSB-SC signal is subjected to intentional interference I(t). The received signal is of the form,

y(t)=10 $x\,(t)\cos(2\,\pi f_c t)$+I(t)

Where

x(t)=cos(2 π10000t)

and

I(t)= $\sqrt{2}\cos(2\,\pi(f_c + \Delta f)t)$ where Δf<10kHz that is, the interferer is in the passband of the DSB-SC signal,

    a. What is the bandwidth of y(t)?

    b. What is the power in y(t)?

    c. Find the Signal-to-interference power ratio (in dB) at the output of a synchronous receiver?

9. In the BPSK receiver output of the receiver filter is sampled at the bit rate and the sample value compared to a threshold, why the threshold value = 0.

10. In the ASK receiver output of the receiver filter is sampled at the bit rate and the sample value compared to a threshold, why the threshold value not equal to zero.