reveiw lecture

Ex given Fm transmitter is modulated with a single sinusoid whose frequency is 4kHz. The output of no modulation is 100 watt a cross a 50 Ω resistive load.
The peak frequency deviation of the transmitter is carefully increased from zero untill the first side band in the resulting amplitude spectrum is zero

a) The peak amplitude of the total wave form

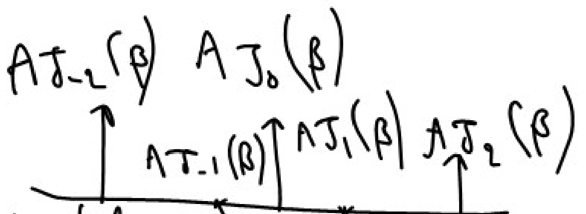
b) The peak amplitude of the upper second order side band

Solution

a) $P_c = \frac{A^2}{2R}$

$100 = \frac{A^2}{2(50)} \Rightarrow A = 100$ volt

b)



From the table of Bessel function we can find that $\beta \simeq 3.8$

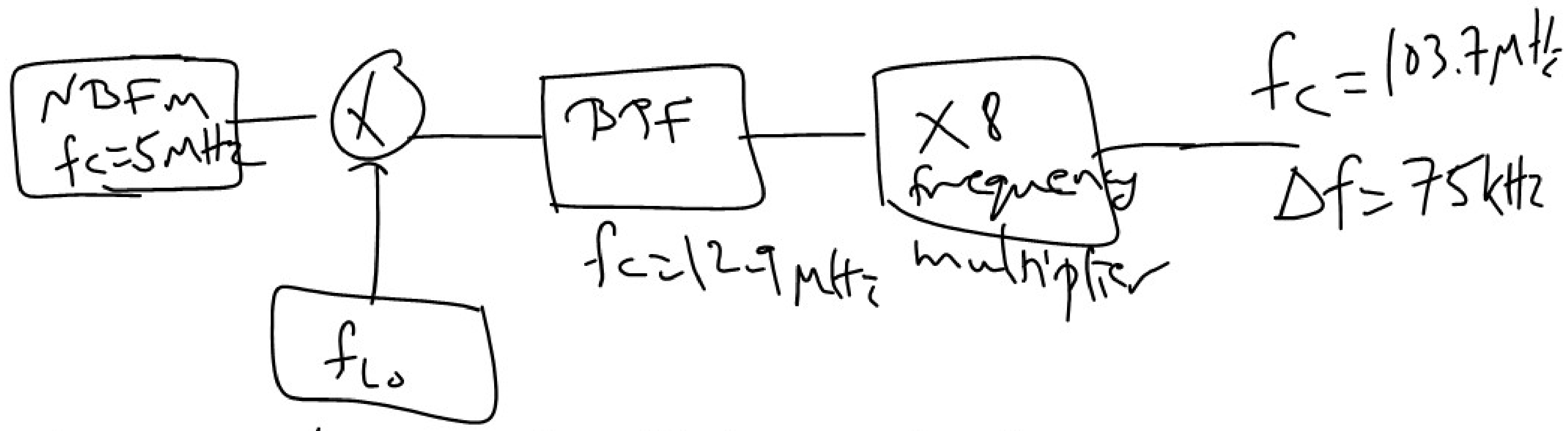
Now The amplitude of the second upper side band is given by $AJ_2(\beta)$

from the Bessel table, we have

$J_2(3.8) = 0.41$

$\therefore 100(0.41) = 41$ volt.

Ex 2 An FM transmitter has the block diagram shown below



a) Find the bandwidth and the center frequency for the bandpass filter

b) Determine the value of f_{Lo}??

c) What is the required peak deviation of the NBFM

Solution

a) The center frequency of the BPF is

$$f_{c_{BPF}} = \frac{103.7\,MHz}{8} = 12.9\,MHz$$

The B.W of the filter can be determined from Carson's rule which is

$$BW = 2f_m + 2\Delta f$$

assume $f_m = 15\,kHz$

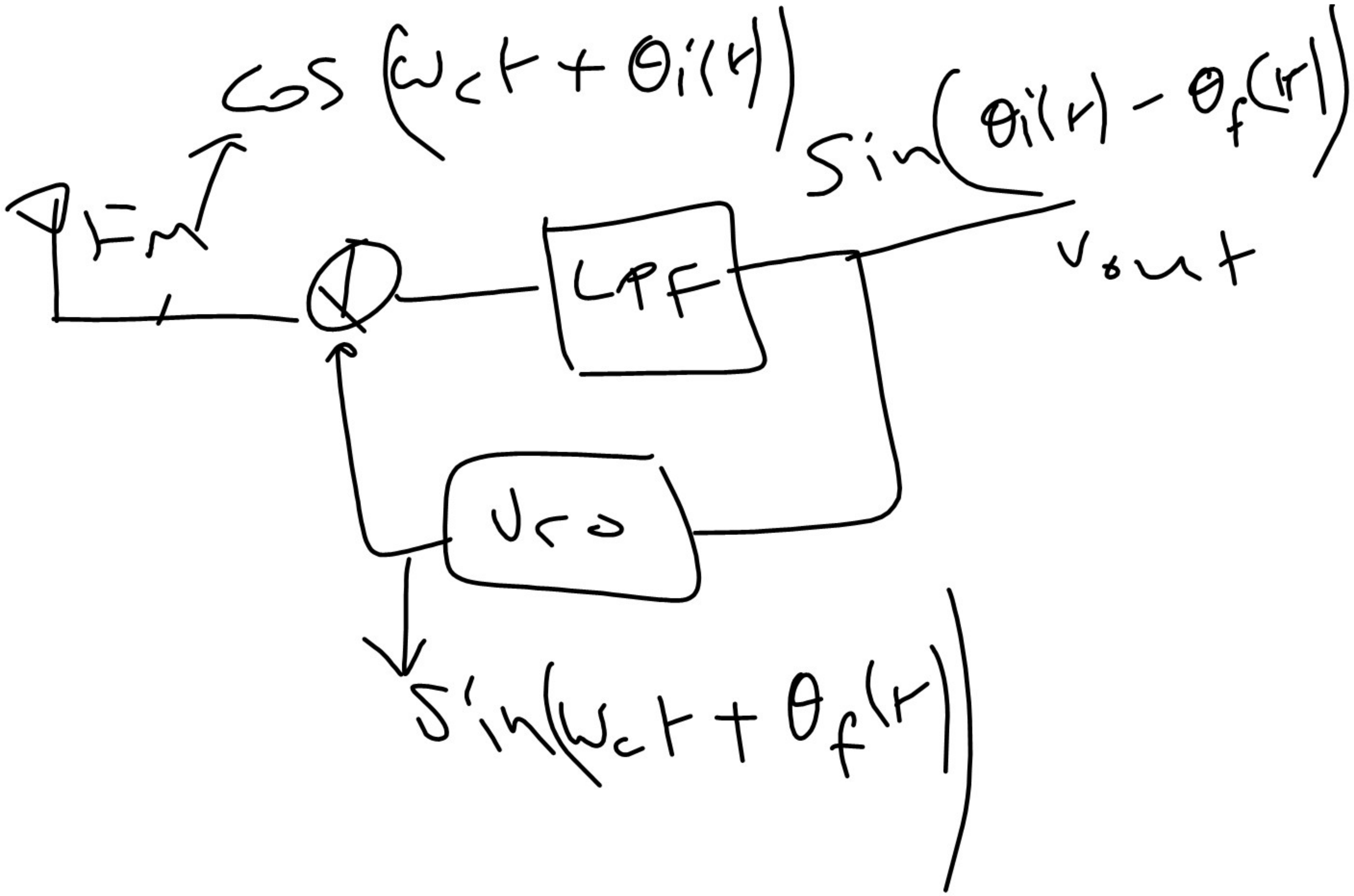
$$\therefore BW = 2(15) + 2\left(\frac{75}{8}\right) \simeq 48.25\,kHz$$

b) The local oscillator frequency can be found by using one of these equations

$$f_{Lo} + 5\,MHz = 12.9\,MHz \Rightarrow 7.9\,MHz$$
$$f_{Lo} - 5\,MHz = 12.9\,MHz \Rightarrow 17.9\,MHz$$

c) The peak frequency deviation of the NBFM block can be found from

$$\Delta f_{NBFM} = \frac{\Delta f_{WBFM}}{8} = \frac{75}{8} = 9.375\,kHz$$


FM
cos(ω_c t + θ_i(t))
LPF
sin(θ_i(t) - θ_f(t))
v_out
VCO
sin(ω_c t + θ_f(t))

Ex Conside a speach signal whose maximum frequency content is 4 kHz sampled at the Nyquist rate.
If each sample is quantized using 256 levels determine

a) Sampling rate

b) The number of bits per second

c) If we record 10 minutes of this speech signal on a hard drive. determine the size occupied by this signal on the hard drive

Solution

a) $f_s = f_{Nyquist} = 2 f_m$

$= 2(4kHz) = 8 kHz$

b) no of bits for each sample is

$n = \log_2 256 = 8$

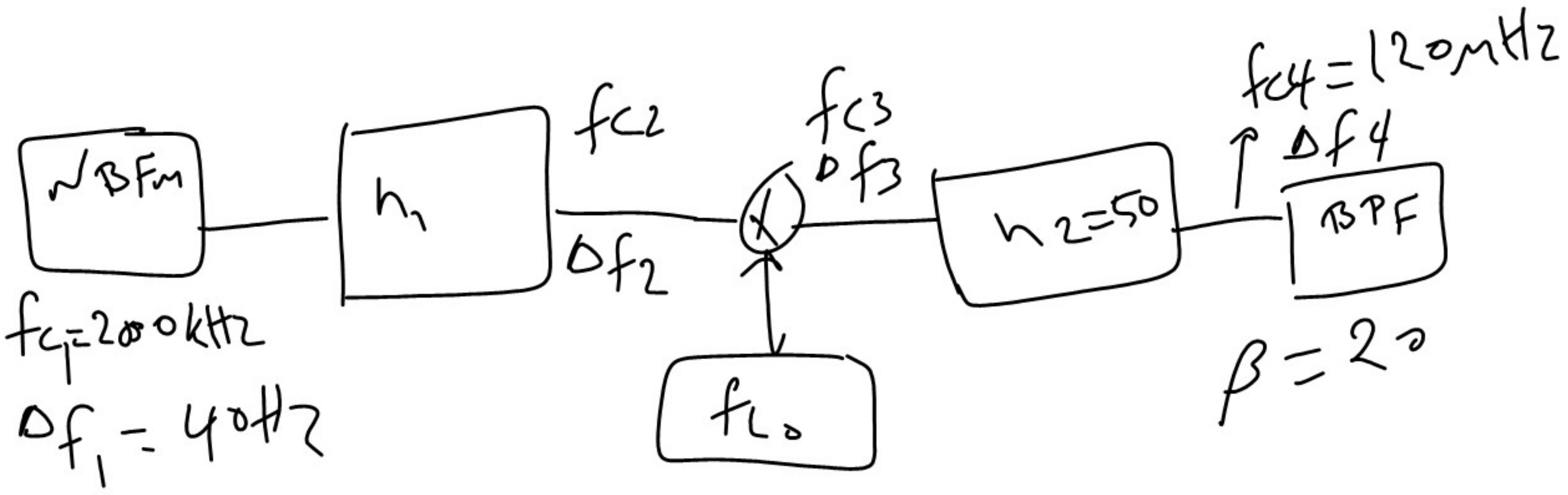
no of bits per second $= n \times f_s$

$= 8 \times 8kHz = 64 \text{ kbits/s}$

c) The required disk space for 10 minutes recording is given by

$BW = \underbrace{64 \text{ kbit/s}}_{R_b} \times (10 \times 60) s$

Simulink in Matla



$f_{c1} = 200\,\mathrm{kHz}$

$\Delta f_1 = 40\,\mathrm{Hz}$

$f_m = 10\,\mathrm{kHz}$

<u>Solution</u>

$$f_{c3} = \frac{f_{c4}}{n_2} = \frac{120\,\mathrm{MHz}}{50} = 2.4\,\mathrm{MHz}$$

$$\Delta f_4 = \beta f_m = 20(10\,\mathrm{kHz}) = 200\,\mathrm{kHz}$$

$$\Delta f_3 = \frac{\Delta f_4}{n_2} = \frac{200\,\mathrm{kHz}}{50} = 4\,\mathrm{kHz}$$

$$\Delta f_2 = \Delta f_3 = 4\,\mathrm{kHz}$$

Note that

$$\Delta f_2 = n_1 \Delta f_1 \Rightarrow n_1 = \frac{\Delta f_2}{\Delta f_1} = \frac{4\,\mathrm{kHz}}{40} = 100$$

$$f_{c2} = n_1 f_{c1} = 100(200\,\mathrm{kHz}) = 20\,\mathrm{MHz}$$

$$f_{Lo} + f_{c2} = f_{c3} \Rightarrow f_{Lo} = 2.4\,\mathrm{MHz} - 20\,\mathrm{MHz} = 17.4\,\mathrm{M}$$

$$f_{Lo} - f_{c2} = f_{c3} \Rightarrow f_{Lo} = f_{c3} + f_{c2} = 2.4 + 20 = 22.4\,\mathrm{MHz}$$