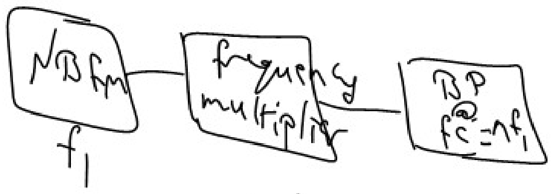
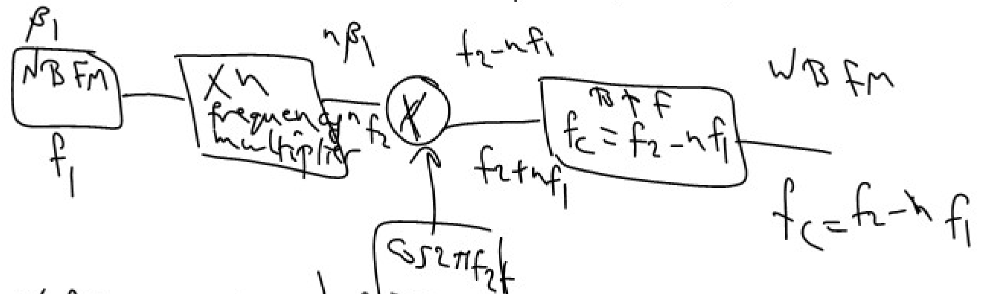
6.6.1 Indirect FM

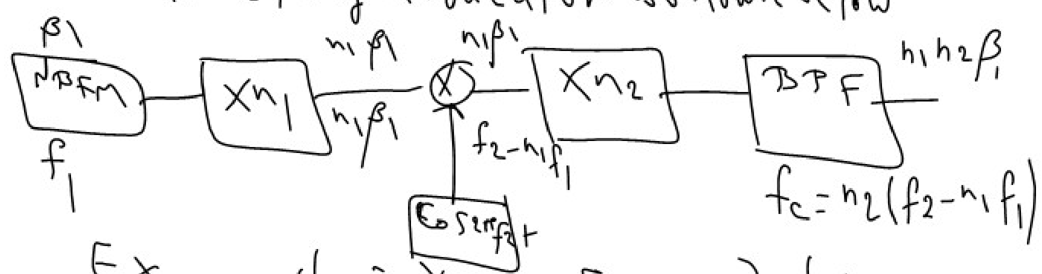
* In the indirect method a wide band FM modulated signal can be generated from a NBFM signal by the use of a series frequency multipliers as shown



* A very large values of β can be attained by using strong nonlinear devices such as Shottky varactor diodes, which has frequency multiplication factors reaches up to 1000
* by using large frequency multiplication factors, the carrier frequency of the WBFM may became un acceptable
* Therefore we can use a down frequency converter before the final stage



* A more modified version from the above indirect WBFM modulator is known as an Armstrong modulator is shown below



Ex For the indirect FM modulator shown above assume $f_1 = 200\,kHz$, $f_2 = 10.8\,MHz$, $n_1 = 64$ and $n_2 = 48$. Determine the possible carrier frequencies at the modulator output and the peak frequency deviation if the peak frequency deviation of the NBFM $= 25\,Hz$

Solution

$$\Delta f = n_1 n_2 \Delta f_1$$
$$= (64)(48)(25) = 76.8\,kHz$$

* The possible carrier frequencies are given by

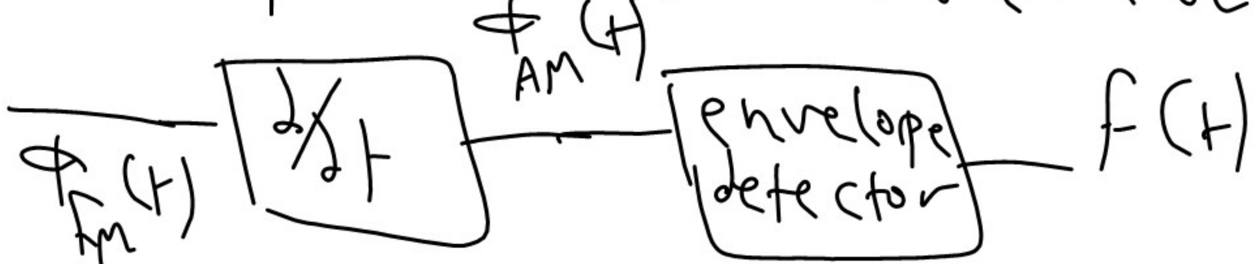
$$f_{c1} = n_2(f_2 - n_1 f_1) = 48(10.8\times10^6 - 64\times200\times10^3) = 96.0\,MHz$$
$$f_{c2} = n_2(f_2 + n_1 f_1) = 48(10.8\times10^6 + 64\times200\times10^3) = 1132.8\,MHz$$

6.7 Demodulation of FM signals

* There are two ways to demodulate an FM Signal, these are
  1. direct demodulation
  2. Indirecte demodulation

6.7.1 Direct Demodulation

* In order to demodulate an FM signal, we differentiate the FM signal, the use an envelope detector as shown below



* to show how the $\frac{d}{dt}$ block convert $\phi_{FM}(t)$ into AM signal consider the following mathematical illustration

$$\frac{d}{dt} A\cos\left(w_c t + k_f \int f(t)\,dt\right) = \underbrace{-A\sin\left(w_c t + k_f \int f(t)\,dt\right)\left[w_c + k_f f(t)\right]}_{\phi_{AM}(t)}$$