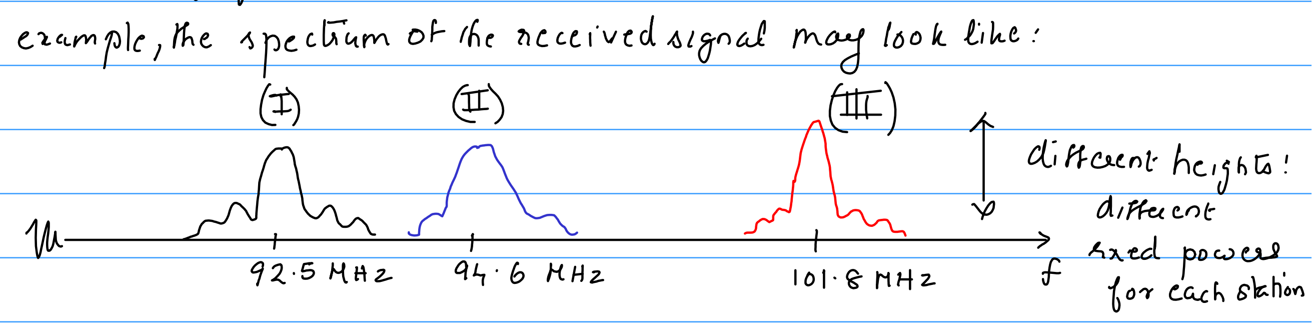
Superheterodyne receivers. (Review of last class).

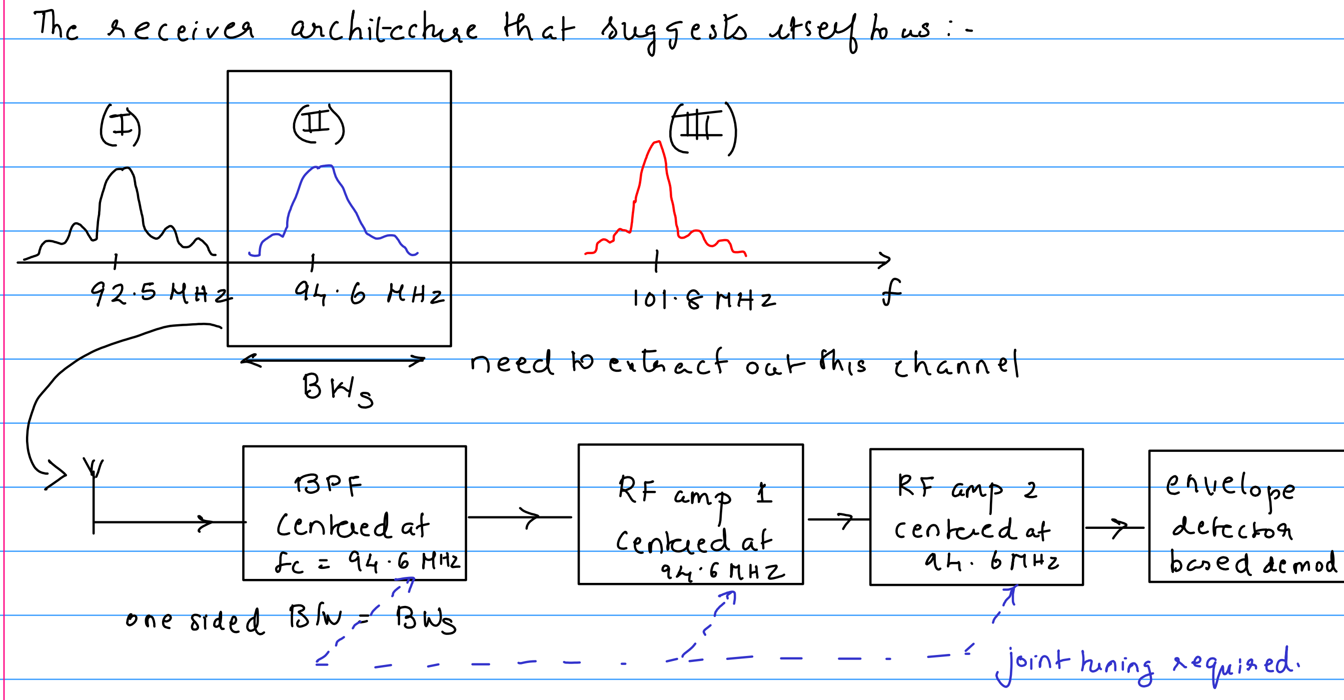
A requirement in broadcast radio is that of listening to a channel or radio station of our choice out of a number of available stations or channels.
Multiple signals (FM or AM) are transmitted at the same time using the idea of frequency division multiplexing. For example, if we are looking at our local FM stations, each station transmits an FM signal at an allotted center freq. The station center frequencies and bandwidths are such that the signals don't overlap.
For example, the spectrum of the received signal may look like:



Our receiver needs to select one of these channels - according to our choice - demodulate the signal at the selected channel. How can this be done?

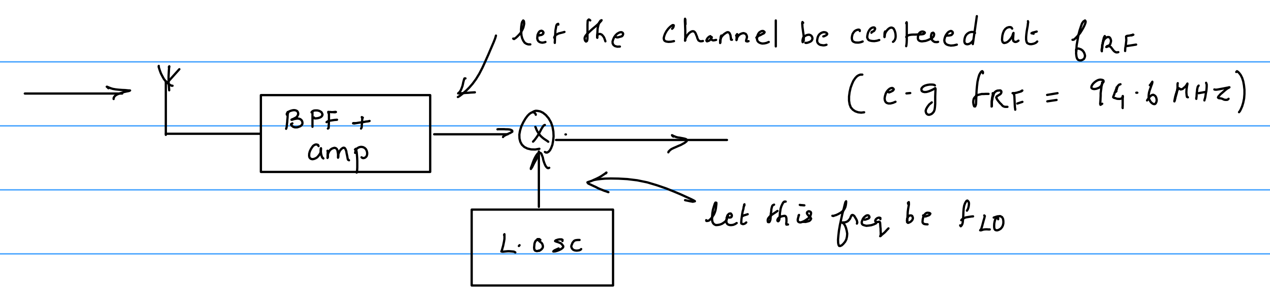
Suppose we need to listen to channel (II) then a filter can be used to select the channel at (II). Note that for either AM or FM a simple receiver structure would use envelope detection - so the demodulation is carried out on a passband signal.
The issue here is that this filtered signal needs to be amplified and if we are operating at the carrier frequency, then doing this amplification at RF freq. requires a high Q factor filter with a large gain - which is difficult to realise.
The superheterodyne architecture helps us to address this issue.

The receiver architecture that suggests itself to us:-



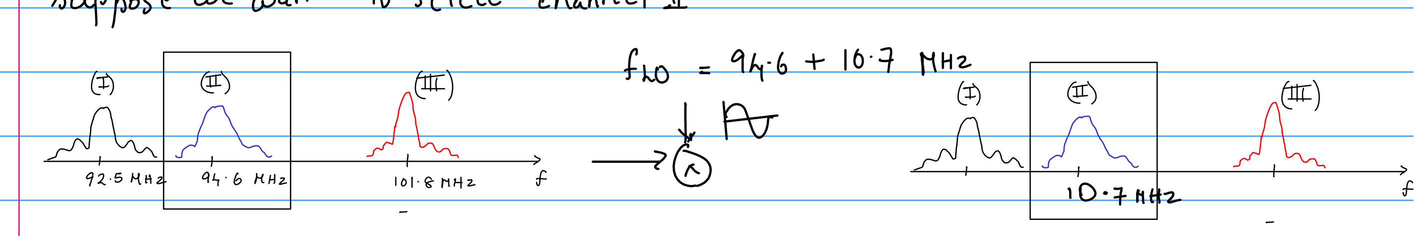
If we only had to receive this channel, then we might be able to design all stages. But difficulty when tuning is required. All stages need to be tuned to receive the same channel together. This arch. is called Tuned Radio Freq. (TRF) receiver.

Superheterodyne architecture - main idea is to translate a channel at our desired center frequency to a fixed frequency - called the intermediate frequency. After translation to intermediate frequency, all succeeding stages can use that frequency. This is done by mixing with a locally generated sinusoid.

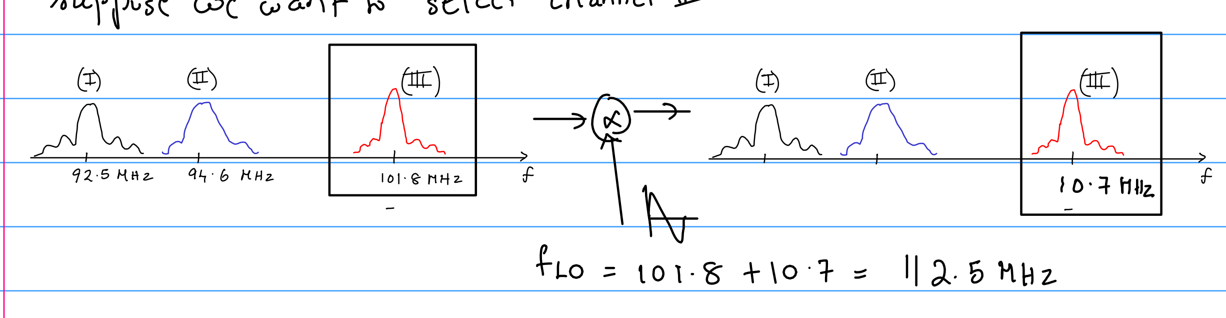


Assume $f_{LO} > f_{RF}$, then after mixing we have the spectrum at 94.6 MHz (or f_{RF}) translated to $f_{IF} = f_{LO} - f_{RF}$ and $f_{LO} + f_{RF}$.
f_{IF} is the intermediate frequency and all succeeding stages work at this frequency. For FM systems, channels are found in the band 88 MHz to 108 MHz and with a bandwidth (one sided) of 200 kHz. The f_{IF} is 10.7 MHz. So f_{LO} is varied between 98.7 MHz to 118.7 MHz in conjunction with the BPF to do the freq translation of channels to f_{IF}.

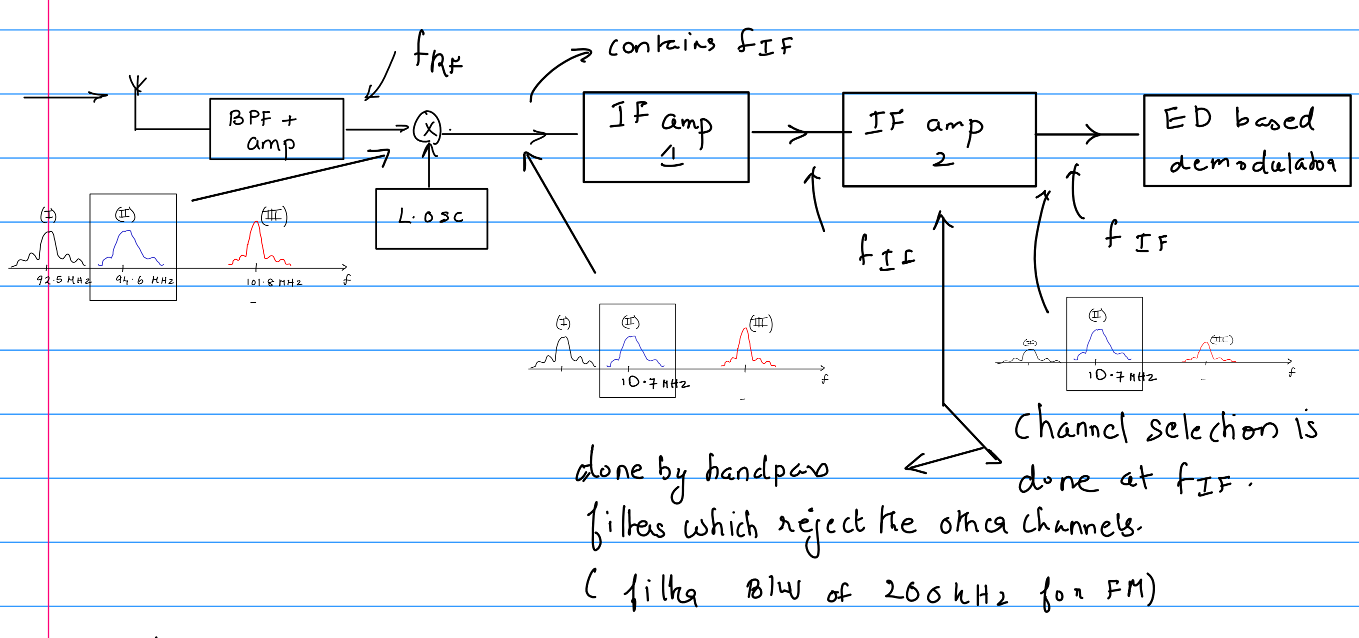
For example:
Suppose we want to select channel II



Suppose we want to select channel III



We note that the required channel is selected by the front end BPF.
After translation to IF, further channel selection and amplification is done by the IF amplifiers.



The front end bandpass filter is not required to do channel selection. But it's major function is to reject interference from what is known as image frequency.

Suppose there is a signal $I(t)$ at a freq of $f_{LO} + f_{IF} = f_{image}$.
Then after mixing this signal also generates a signal at f_{IF} which interferes with our desired signal. The front end bandpass filter needs to reject this image freq.

There are 2 major components of receivers - AGC and PLL which we will cover towards the end of the course.

Now we will start with noise analysis to complete our study of AM and FM systems.