Course on Principles of Communication Systems-Part 1
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Lecture 48
Module 8
Frequency Mixing and Translation, Heterodyne and Super Heterodyne Receivers

Hello welcome to another module in this Massive open online course. So in this module we looked at the different topic that is frequency translation or frequency mixing, ok.

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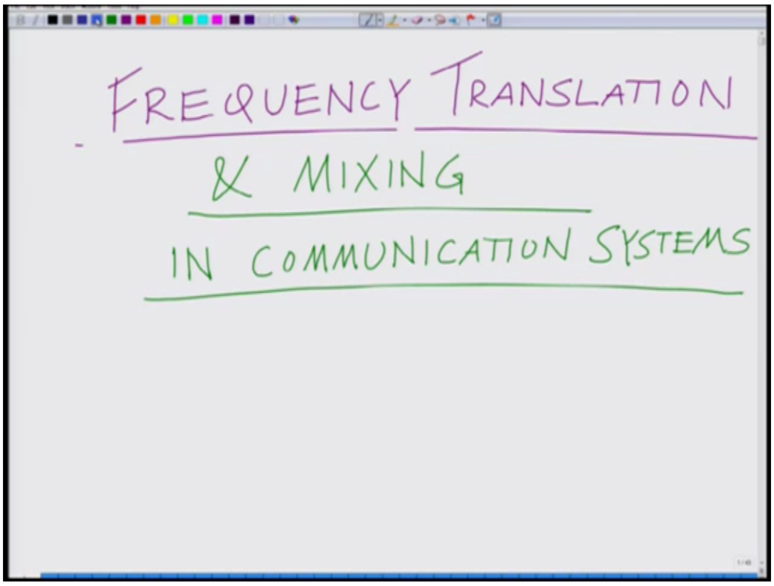

So we will start our discussion on a new topic that is frequency translation in a communication system or frequency mixing, frequency translation or frequency mixing frequency translation and mixing in communication systems in communication systems.

Now this frequency translation alright is the very important idea of frequency shifting through mixing is a very important idea in signal processing at the receiver and the communication system in which all the signals at the different career frequencies like all the various signals that can be received right at the receiver are sifted or translated to a common frequency, ok.

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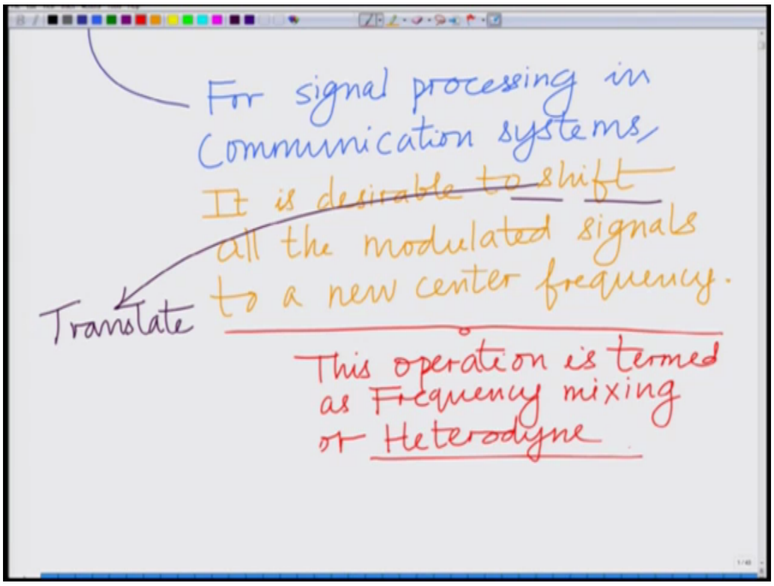

So this in the processing of signals in the processing of signals in communication systems it is desirable to shift or translate the modulated signals at the receiver to a new center frequencies, so in or for signal processing in communication systems for signal processing in communication systems it is desirable it is desirable all the modulated signals or translate all the modulated signals to a new center to shift all the modulated signals to a to a new center frequency either shift or basically this can also be seen as translate translation is nothing but shifting.

So we would like to shift or translate all the all the modulated signals received modulated signals to a new frequency alright. This operation is termed as now this operation is termed as so this is termed as frequency mixing or heterodyning, this operation is termed as frequency mixing or heterodyne or heterodyning, ok this operation frequency mixing or the receiver this is termed as the heterodyne receiver alright which performs this heterodyning operation alright.

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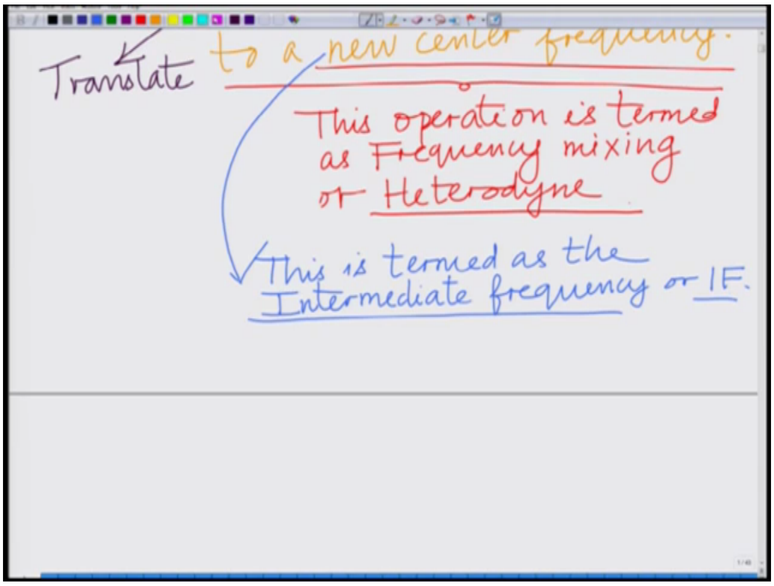

And this new center frequency alright this new center frequency is common center frequency to which all the received centers signals are translated this is termed as the intermediate frequency IF this new center frequency this is termed as the intermediate frequency this is termed as the this is termed as the intermediate frequency or IF, ok.

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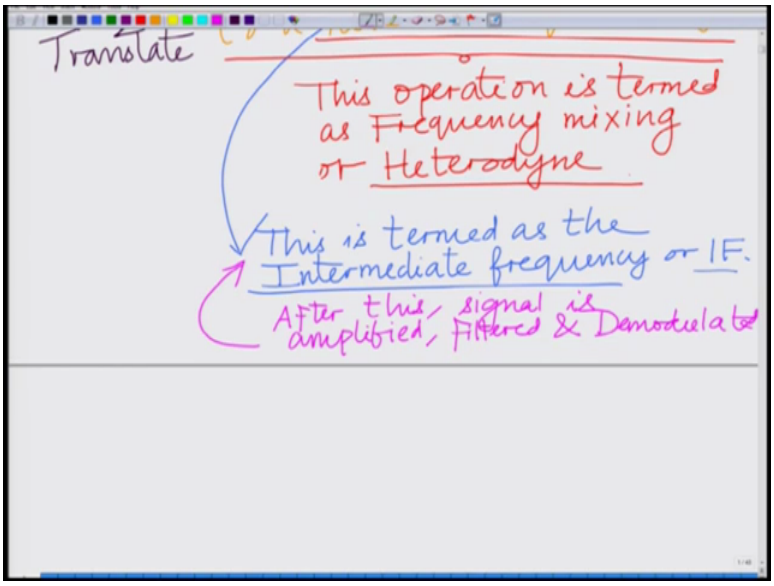

After this the signal is amplified, filtered and demodulated after this amplified, filtered and after this the filter is after this the signal is amplified, filtered and demodulated, ok. So this is termed as the intermediate so all the frequencies the modulated signals are translated for common center frequency and new center frequency which is termed as the intermediate frequency this process is called as the frequency translation or mixing or basically heterodyning, ok this is done in a heterodyne receiver, ok.

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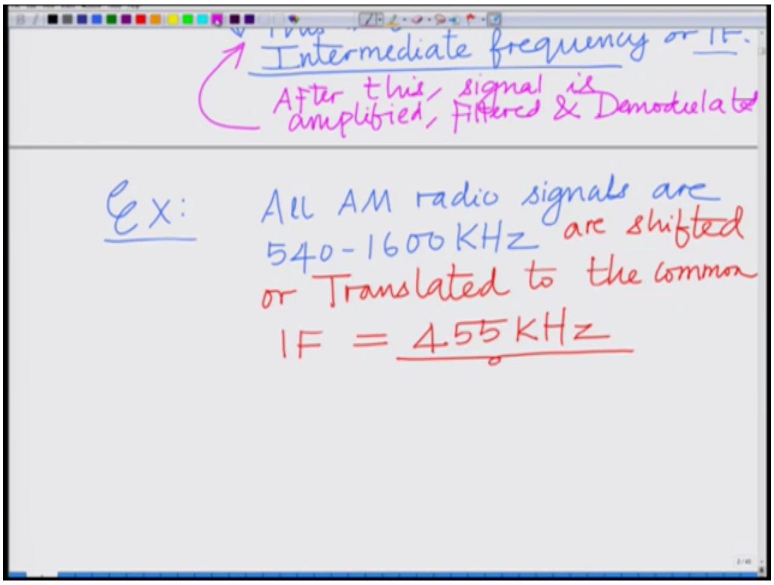

Now for instance for instance let us take an example, all the amplitude model all AM radio signals all the amplitude modulated radio signal all the AM radio signals that is in the 540 to 1600 Kilohertz when there is all the radio signals at this different characteristics in the different center career frequencies this bank are shifted to the common frequency shifted or translated to the common intermediate frequency equal to 455 Kilohertz, this is your intermediate IF for basically the intermediate frequency, ok.

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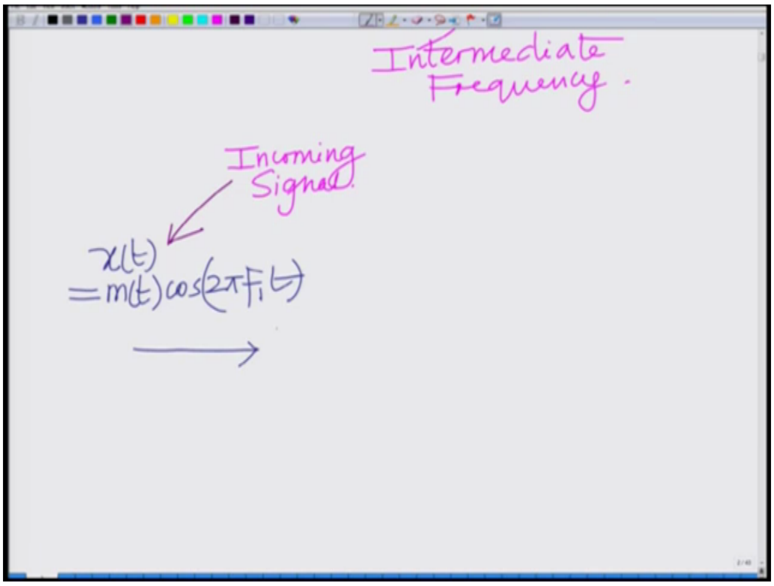

This is your IF or intermediate frequency and how is this achieved this is achieved as follows for instance let us say I have x(t) which is the incoming message signal incoming signal modulated signal m(t)cosine(2piF1t) so this is the incoming signal, ok so this is your incoming signal now what I am going to do I am going to mix this I am going to demodulate this operation is known as this process is known as mixing mixing is nothing but demodulating but with the different frequency.

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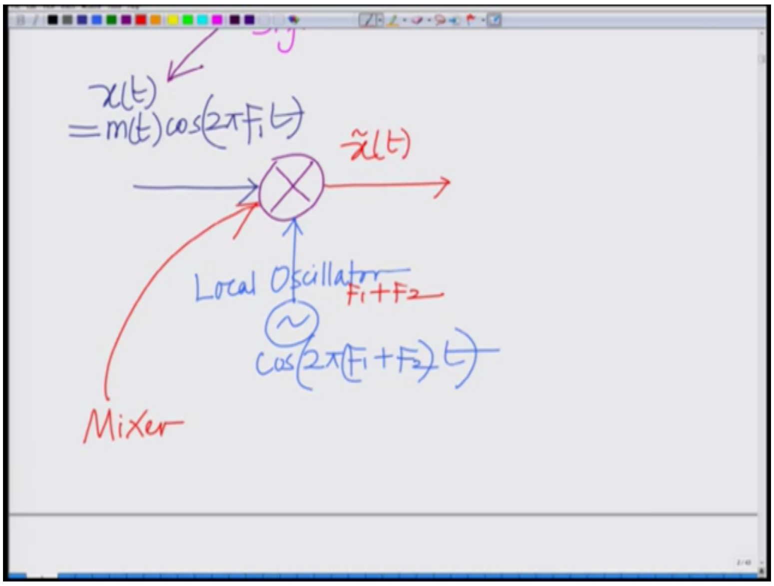

So you are mixing it with the different frequency that is the whole idea so I am demodulating this with a different frequency I am mixing this, so this is a local oscillator. Now in a coherent demodulator we demodulate with the same frequency F1 is the frequency career frequency of the incoming signal we demodulate it with F1 but here we are using we use a different frequency F2 alright demodulating or mixing with this frequency multiplying with this frequency career of frequency F2, ok.

So I have this local oscillator which generates this career at to Cosine (2 pi not F2 but (F1 plus F2) t) ok so mixing with so this local oscillator basically corresponds to frequency so the local oscillator corresponds to frequency F1 plus F2 this basically is a mixer ok, this is basically what it is doing is performing a mixing operation mixer basically is mixing there is an incoming signal frequency F1 signal local oscillator frequency F1 plus F2 this this demodulate is basically this mixer is mixing these two signals and we get an output. Now what is the output that we get so let us call this output x tilde (t).

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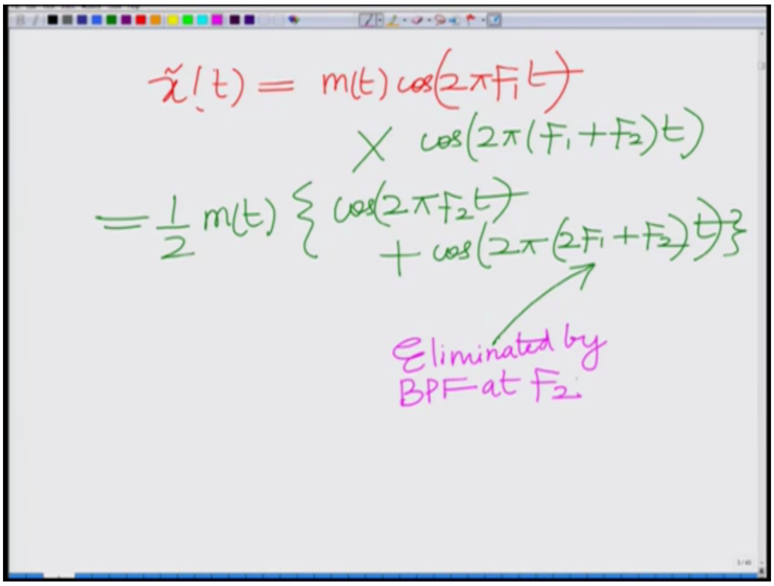

Now let us examine this output x tilde (t) x tilde (t) equals this is equal to m(t) cosine (2pi F1t) times that is your x(t) times cosine (2pi(F1 plus F2)t) that is a career frequency of the mixer that gives me half m(t) {cosine (2pi F1t) into cosine (2pi(F1 plus F2) into F2 t) so this is half cosine 2pi F1 plus F2 minus F1 F2 t plus cosine (2pi F1 plus F1 plus F2 that is 2F1 that is basically you are your (2F1 plus F2) t)}.

Now this is at a much higher frequency though this can be eliminated by band pass filtering that is band pass filtering at F2. This 2F1 plus F2 can be eliminated by band pass filtering at center frequency F2.

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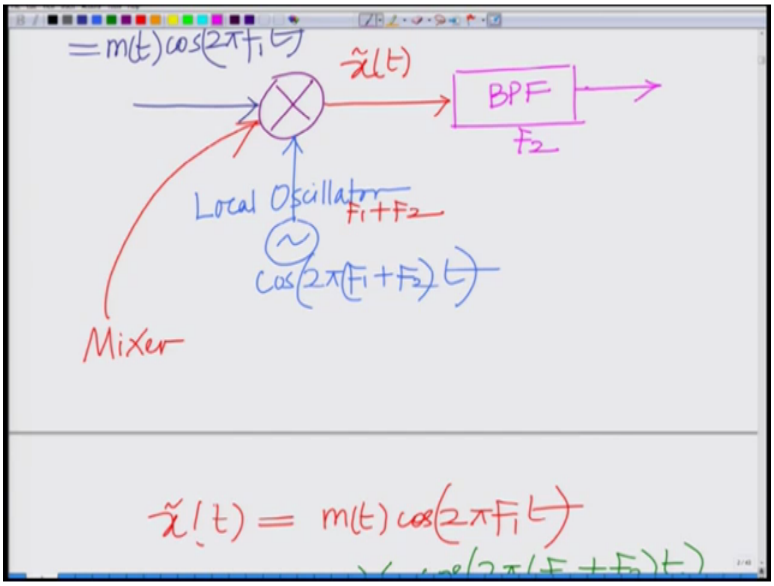

Therefore what we have to do is at the output we have to pass it through a band pass filter centered at F2.

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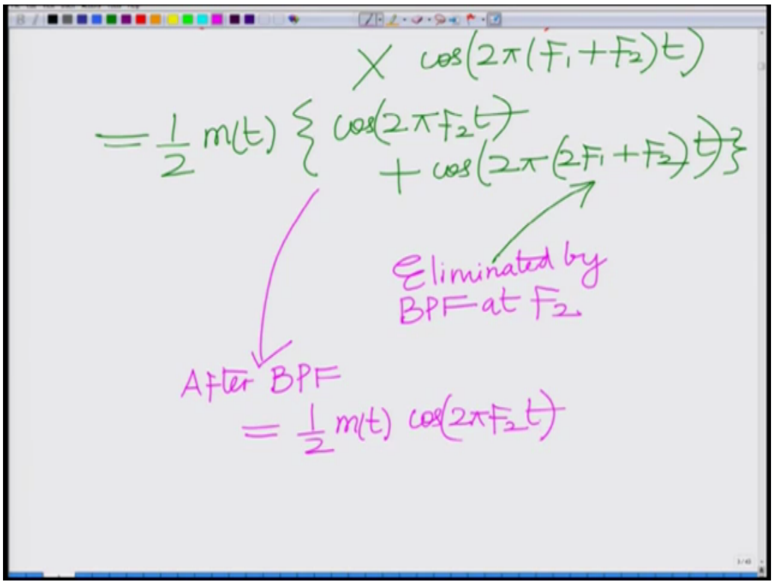

And once you pass it through a band pass filter centered at F2 this component gets eliminated what we get after BPF after BPF is half m(t) into cosine (2pi F2t).

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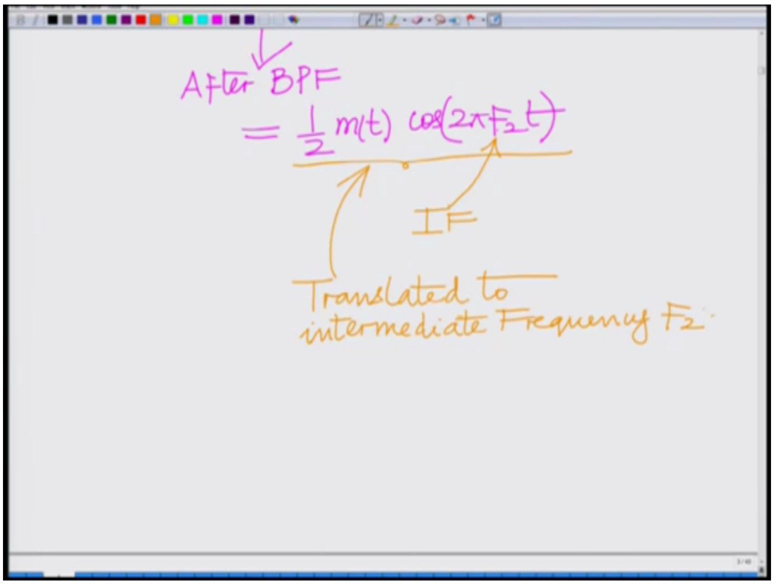

So now you can see it is translated to this new frequency F2 where F2 is the intermediate frequency so this F2 is nothing but IF that is the intermediate frequency. So this is translated translated to the intermediate frequency F2 translated to the intermediate frequency F2.

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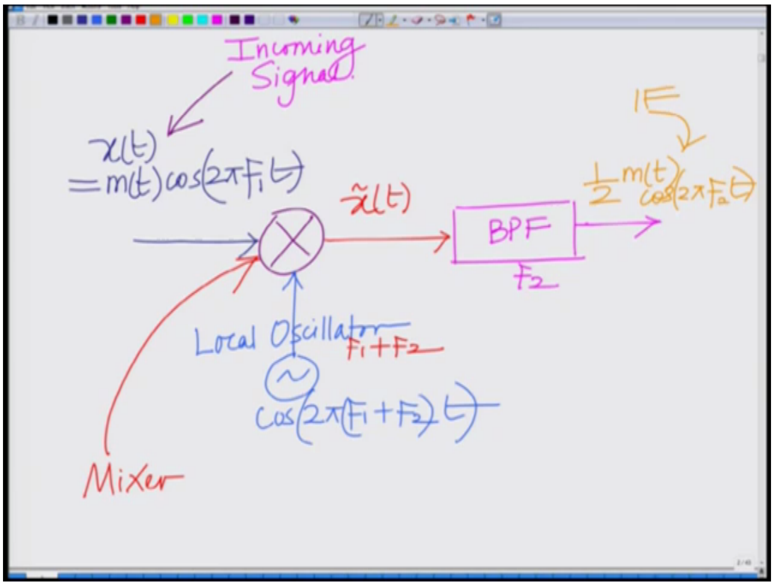

And therefore the output of this will be half m(t) cosine (2piF2t). This is your IF signal intermediate frequency signal, ok.

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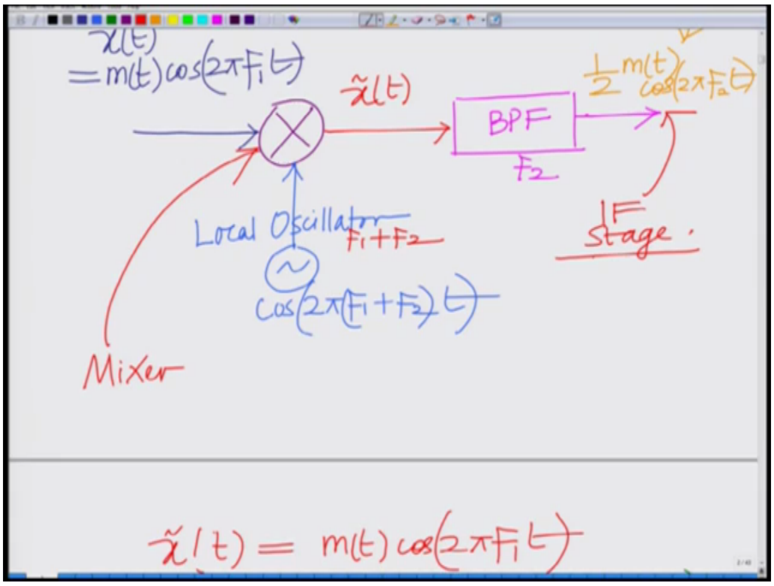

So basically what we are doing is we have this F1 incoming signal with incoming signal with carrier frequency F1 mixing with we are mixing with locally generated carrier which has frequency F1 plus F2 and therefore after you band pass filter the output you get the next signal with at the intermediate frequency m(t) half m(t) cosine (2piF2t) which is at the intermediate frequency IF F2. So this is the IF stage. So basically this is your intermediate frequency stage.

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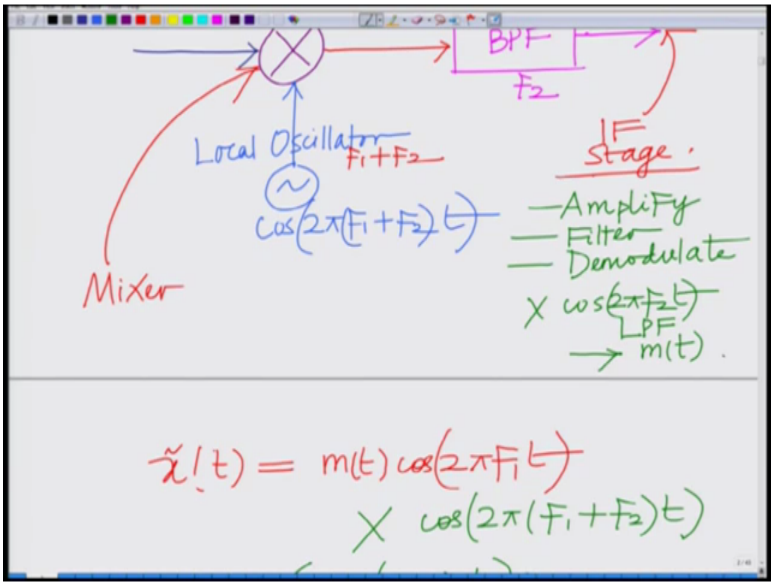

In this IF stage the signal is (automa) suitably as we said in the IF stage signal is signal is amplified, filtered and then demodulated. So in the IF stage signal is suitably amplified so we first amplify, we filter and we demodulate demodulate in the sense multiply by F2 carrier frequency F2 remember now the IF stage has frequency carrier frequency F2 because it is cosine (2piF2t) so you multiply by cosine (2piF2t) followed by low pass filtering, ok. That is again the followed by and then LPF which gives you your m(t) basically ok. So that is what we are doing, ok.

So that basically describes this property of translation or mixing there what we have seen is basically we have incoming signal carrier frequency F1 all such so various possible different carrier frequencies signals of various possible carrier frequencies are translated to common intermediate frequency that is F2 this operation is known as translation alright frequency translation or basically heterodyning, ok.

And this now the incoming signal can a have a different frequency F1 alright therefore the mixing frequency F1 plus F2 is also going to change however the F2 that is the frequency of the intermediate frequencies this is going to remain constant, alright this IF the intermediate frequency F2 is always constant alright.

So all the (freq) all the signals modulated signals irrespective of F1 are mixed by F1 plus F2, to bring them or to translate them to a common intermediate frequency F2, alright alright so this is the operation in a heterodyne receiver alright so we will stop here and continue with this in the subsequent module, thank you.