Principles of Communication- Part I
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Module No 5
Lecture 30
Indirect Method for Generation of FM Signals - Generation of Narrowband FM Signal

Hello welcome to this another module in this massive open online course, so we are looking at angle modulation, so we are looking at angle modulation which comprises of basically two kinds of techniques either phase modulation and frequency modulation we have looked at the different kinds of we have looked at the properties of frequency modulated signals, alright and also representations of frequency modulated signals. In this module let us start a looking at the generation of frequency modulated signals, alright. In particular let us start with the generation of narrowband frequency modulated signals, okay.

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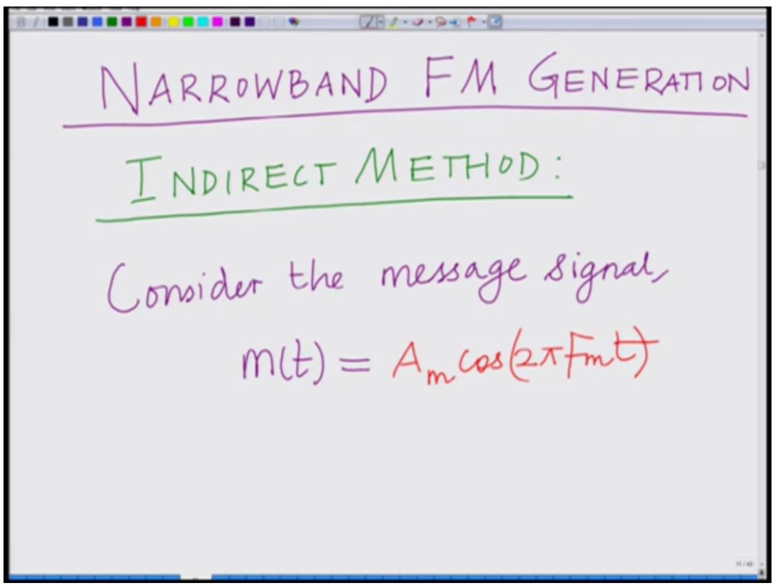

So what we would like to do is we would like to start with a discussion of generation of frequency modulated signal in particular let us start with a simplistic scenario where we have narrowband where we start consider narrowband narrowband Fm signals. Narrowband, so we want to look at narrowband Fm signals and we want to look at narrowband Fm generation in particular, okay. So basically we want to look at the generation of narrowband FM signals and in this we will start with a technique known as the indirect the indirect method for narrowband Fm signal generation, okay.

So consider the message signal, so let us say consider the message let us say we have the message signal. M(t) equals Am cosine two pi Fmt this is our message signal, okay. So we are considering the message signal Am cosine two pi Fmt towards illustrating this process of generating a narrowband Fm signal, alright.

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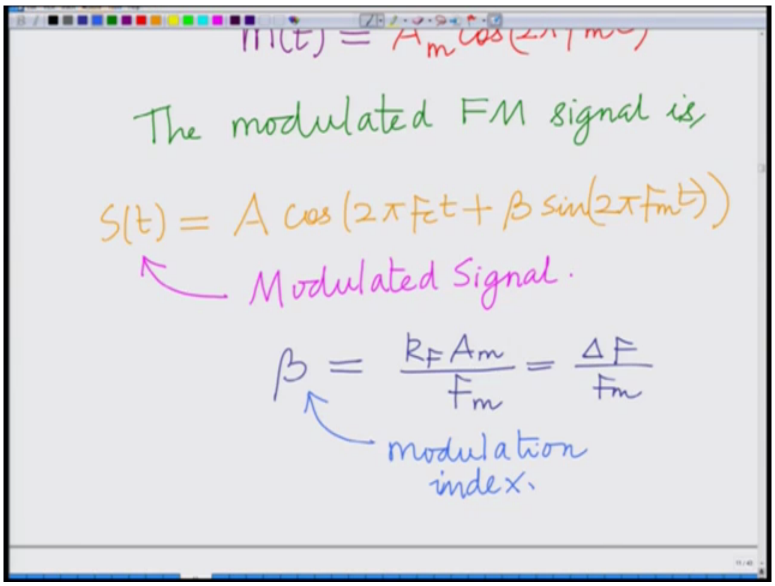

Okay, now let the modulated Fm signal be we have already seen that the modulated Fm signal is S(t) equals since this is a Sinusoidal modulating signal we have already seen the corresponding modulated signal A A cosine two pi Fct plus beta sin two pi Fmt this is your modulated signal, correct? So this is basically the this is basically the modulated signal and what we have seen is this value beta the value of this modulation index beta for this scenario is kFAm divided by Fm which is basically your Delta F divided by Fm.

So this is your modulation index beta, okay. That also we know, so this is your this is the modulation index beta, okay. So now we would like to generate a narrowband Fm signal let us consider a signal in which this modulation index beta is very small, alright. Later we are going to (illus) later we are going to describe how to generate and Fm signal where beta is where beta is not very small or beta is beta has some nominal value, okay.

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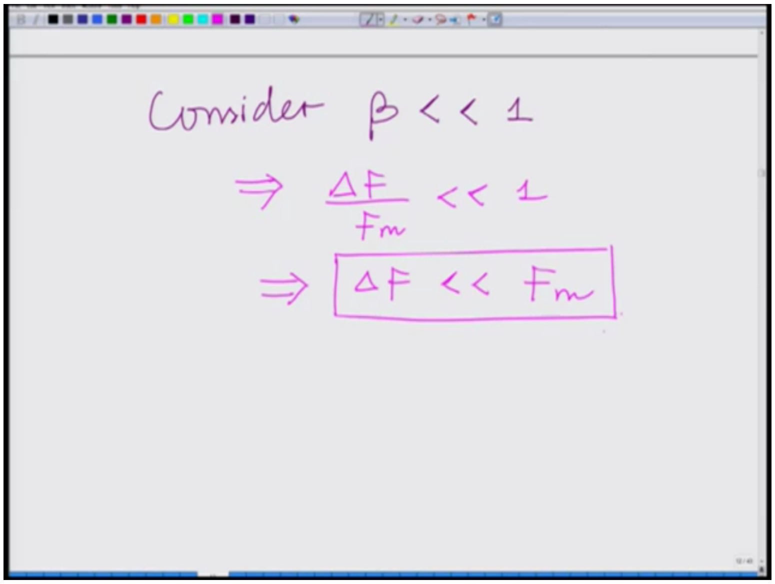

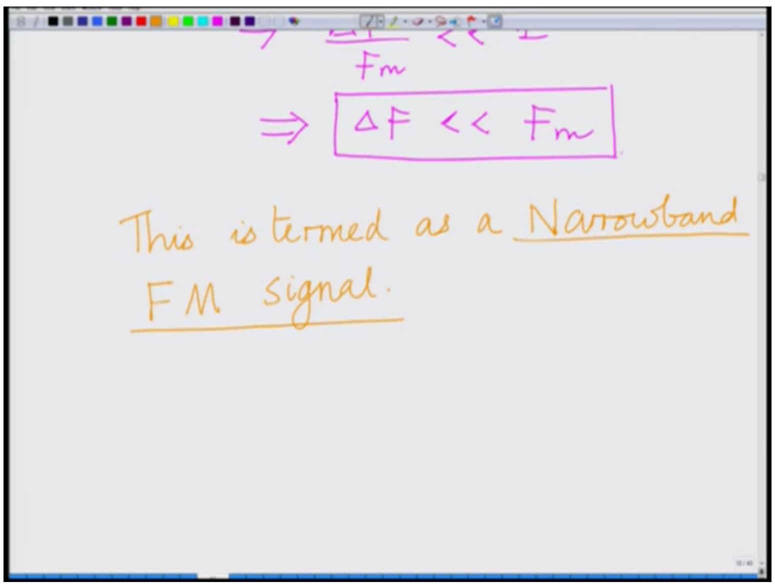

So to begin with let us consider a scenario with very small beta that is a modulation index beta, alright. So consider to begin with consider beta significantly less than one this implies that basically your Delta F by Fm beta is Delta F by Fm is significantly less than one. Which implies Delta F is significantly less than M Fm, now this is termed as a narrowband FM signal. This is termed as a narrowband FM signal that is a signal for which beta is significantly less than one that is beta is very small this can be considered as a narrowband Fm signal for the reason that the spread the bandwidth occupied by this signal is going to be very small.

As we are going to see when we discuss the bandwidth of an FM signal, alright. So when beta this modulation index is very small the bandwidth of (())(6:29) by the FM signal is indeed very small, okay. So we call such an FM signal and narrowband FM signal, okay. And now this narrowband FM signal for this narrowband FM signal for such a narrowband FM signal we have.

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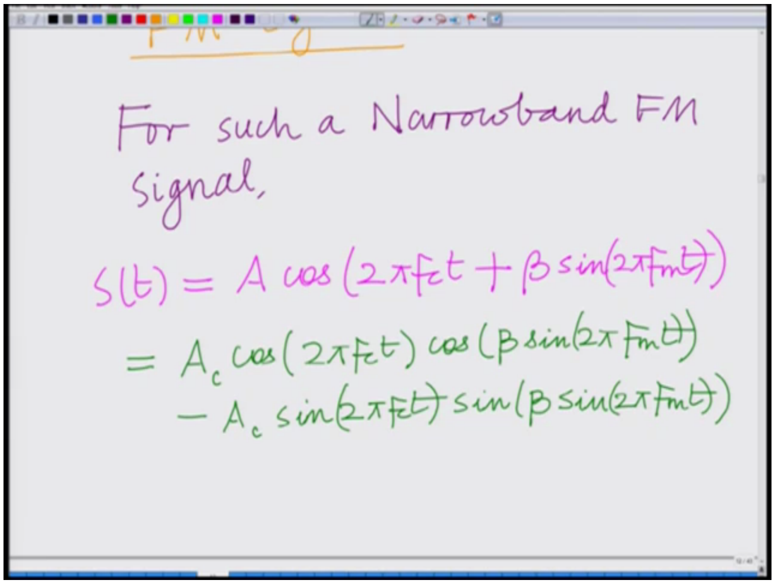

Now for such a narrowband FM signal now for such a narrowband FM signal we have S(t) equals A cosine two pi Fct plus beta sin two pi Fmt. Now this can be simplified for using the properties of the cosine function as using the trigonometric properties that is A cosine a plus b cosine a is cosine a cosine b minus sin a sin b, so this is cosine two pi Fct cosine beta sin two pi Fmt minus Ac sin two pi Fct into sin beta sin two pi Fmt, alright. So we have simplified this modulated signal Ac cosine two pi Fct plus beta sin two pi Fmt, okay.

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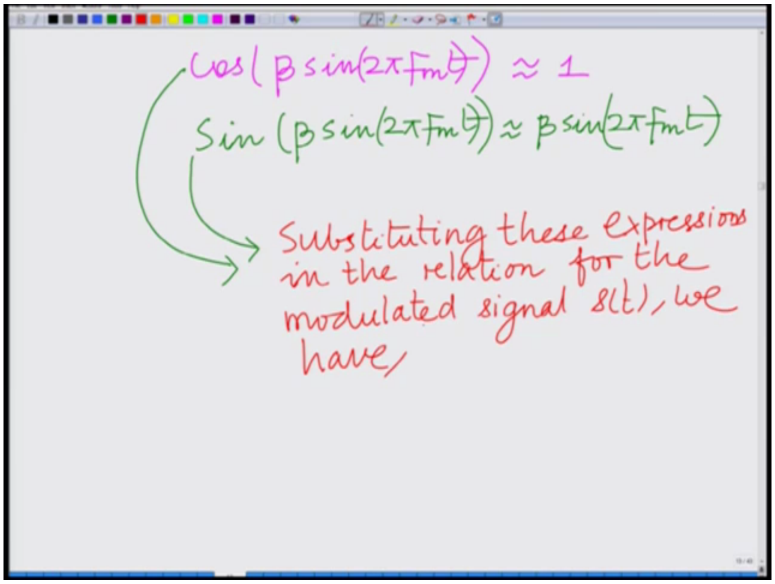

Now we are going to employ the property that is for small beta. That is for small beta for small beta we have, well for small beta cosine beta sin two pi Fmt this is approximately equal to one because beta small, so cosine theta is small for small Theta cosine Theta is approximately one and for small Theta sin theta is approximately equal to theta so employing this approximation sin of beta sin two pi Fmt is approximately equal to beta sin two pi Fmt. For small Theta sin theta is approximately equal to theta.

So therefore sin beta sin two pi Fmt is simply beta approximately beta sin two pi Fmt, now when we substitute this in the expression so substituting these so now substituting these in the expression for the modulated signal S S(t), so what we are going to do is we are going to substituting these expressions substituting these expressions in the relation or in the expression for the modulated signal s S(t).

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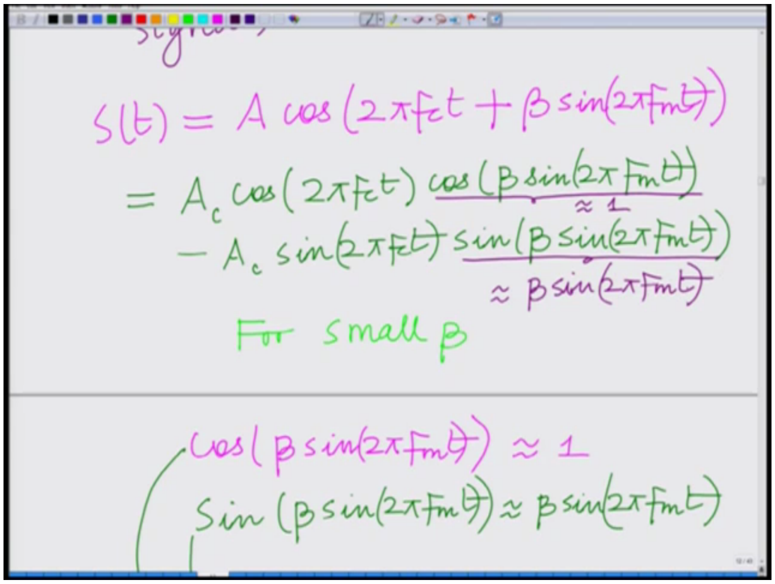

We have S(t) equals well, A cosine two pi Fct A cosine two pi Fct into cosine beta sin two pi Fmt that will be one. Since, so what we have here is this cosine beta sin two pi Fmt this is approximately one and sin beta sin two pi Fmt this is approximately equal to beta sin two pi Fmt.

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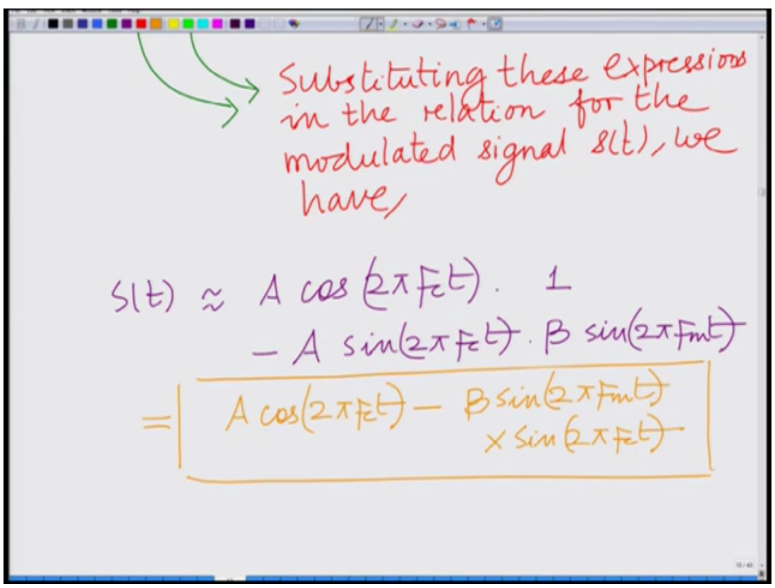

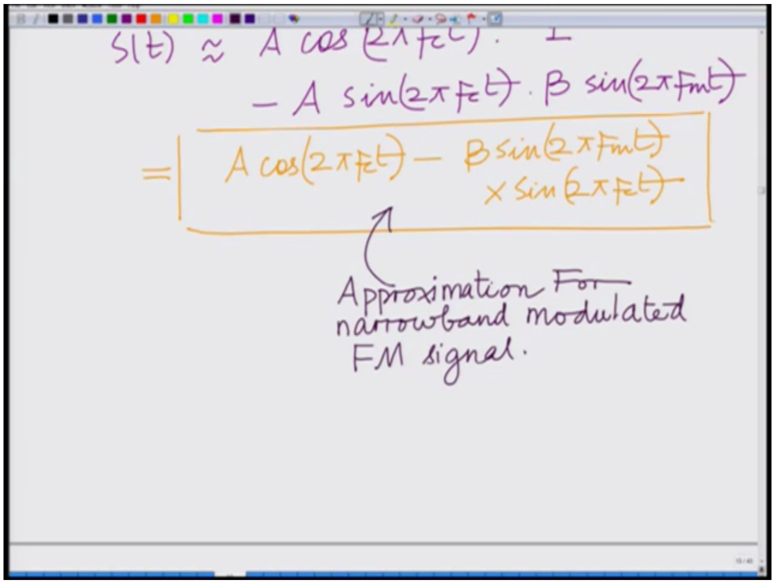

So substituting these we have Ac cosine two pi this is approximately equal to Ac cosine two pi Fct one minus A sin two pi F that is sin two pi Fct into beta sin two pi Fmt which is equal to A cosine two pi Fct minus beta cosine two pi Fmt into sin two pi Fct and this is the approximation for your narrow band modulated, so this is basically we are going to employ this approximation for the narrowband modulated FM signal.

So this is an approximation this is the approximation for this is the approximation for the narrowband since the approximation for our narrowband modulated FM signal and we are going to employ this approximation for the generation of the FM signal and you can see this is reasonable as simple with this approximation because now the modulating signal is out of the phase component and it is in the (fro) form of a product of the carrier and the message signal, alright.

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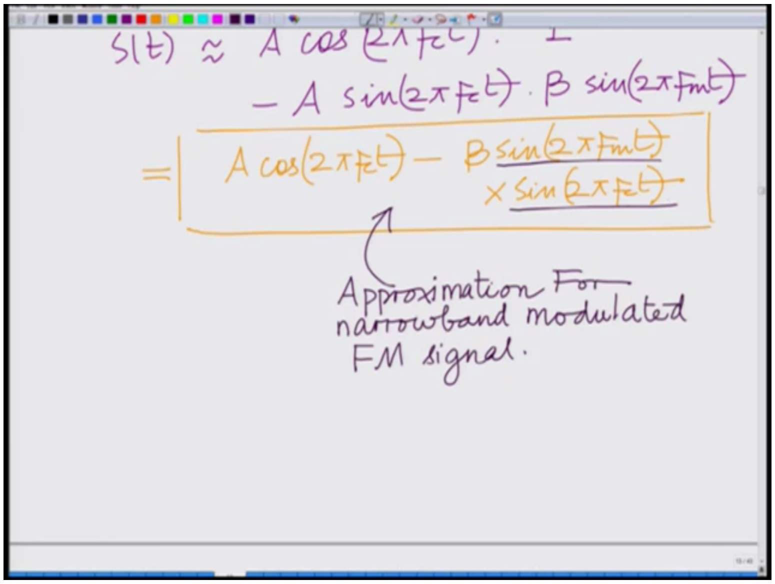

Say you can see this is basically in the form of a product that is sin two pi Fmt into sin two pi Fct.

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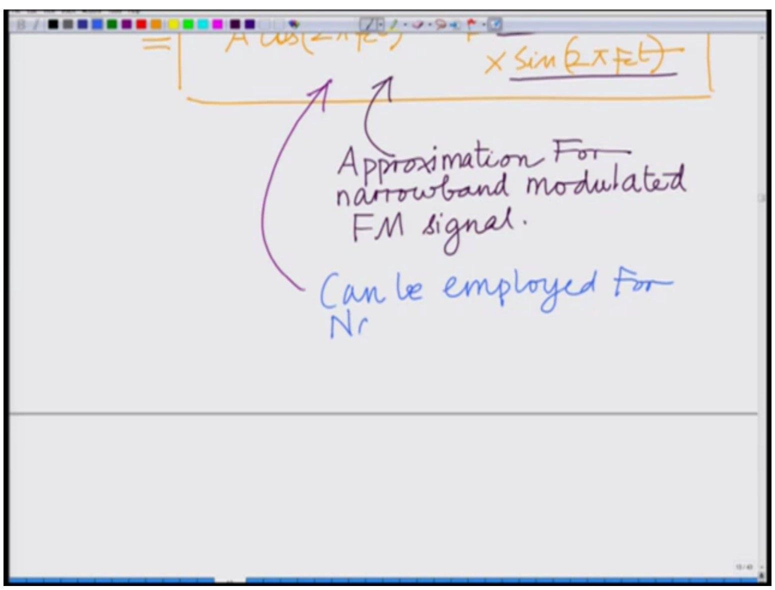

So now basically we can generate this narrowband, so now you can generate this narrowband modulated FM signal so this can be employed to generate the, so and this approximation can be employed so this approximation can be employed for this approximation can be employed for narrowband FM generation.

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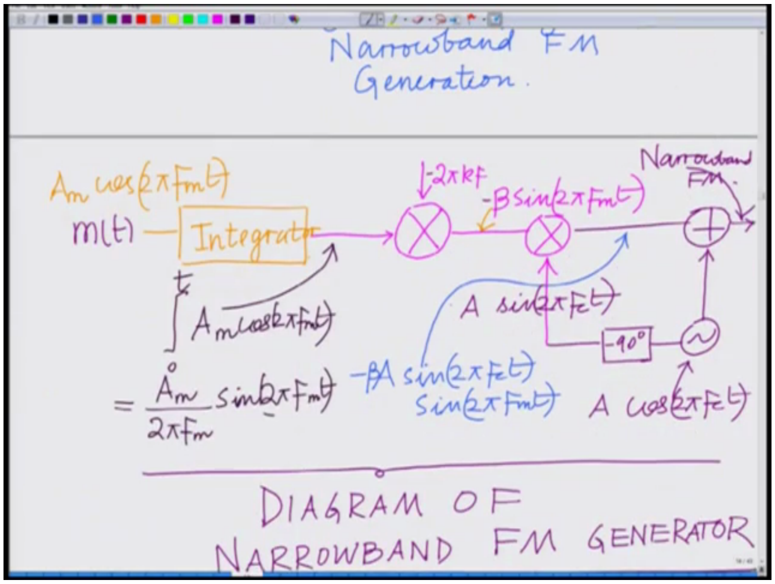

So let us look at how to generate that? So I have m(t) which I can basically this is your message signal I can basically pass it through an integrator, right? Correct? That is your cosine two pi Fct that integrate gives sin two pi, so I can pass this pass it through the integrator, correct? So this is let us say your Am this is your Am cosine two pi Fmt you pass it through the integrator at this point you will have so you will have integral zero to t Am cosine two pi Fmt at this point you will have Am cosine two pi Fmt integral zero to t Am cosine two pi Fmt which is basically equal to, well this is Am divided by two pi Fm sin two pi Fm sin two pi Fmt.

So this you multiply at this point you multiply this by when you multiply this by two pi into kF so you multiply this by two pi into kF. So you take the output of the integrator multiplied by 4 two pi into kF, first multiplied by this factor two pi into kF and also multiplied by this multiplied now this is basically multiplied by this if so that gives you beta so this gives you basically your beta sin two pi Fmt.

Which at this point you multiply by you multiply by you modulated with the cosine signal that is Ac cosine or Ac sin two pi Fct Ac sin two pi Fct and so you have this Ac sin two pi Fct which can in turn be generated by a ninety degree phase shift by a ninety degree phase shift from a cosine modulator. So I have a cosine modulator which is generating your oscillator rather, so this is your Ac cosine Ac cosine two pi Fct and this signal.

Let us say and this signal you add this over here so you have Ac cosine two pi Fct minus or you have A cosine two pi Fct minus and let us say I have this minus two pi kF, so this will be so this will be minus beta sin two pi Fmt times Asin two pi Fct, so what we have here will be the narrowband FM so this will be narrowband FM the output of this will be your narrowband FM, okay so this is basically your schematic diagram or diagram of narrowband FM generator, okay.

So this is basically your diagram for a this is the diagram of your narrowband FM, diagram of a simple narrowband FM generator, so I am taking Am cosine two pi Fmt passing it through an integrator that gives me Am by two by Fm sin two pi Fmt, so multiplying that by two pi kF or minus two pi kF that gives me, so minus beta sin two pi Fmt that will be the output here, so this is modulated through this A sin two pi Fct, alright.

And the same thing is also again to the same thing we add Ac cosine so you have at this point or at this point you have at this point you have A sin two pi Fct or minus beta A sin two pi Fct into sin two pi Fmt that is what you have at this point, so minus beta sin two pi Fmt sin two pi Fct that is what you have at this point to that you add A cosine two pi Fct and that gives you your narrowband FM signal. So this is basically the narrowband FM generator, alright.

So this is a simple schematic diagram for the narrowband FM generator, alright. So in this module what we have seen is we have technique to generate the narrowband FM signal we have seen that the narrowband FM signal is the signal for which the beta that is the modulation index beta is significantly lower than one that so using an approximation for that, right. A reasonable approximation for this scenario where beta is much less than one.

We have simplified this expression for the modulated narrowband FM signal and based on these approximation for the narrowband modulated FM signal we illustrate a simple scheme to generate this narrowband FM modulated signal, alright. By modulating the signal appropriately with a integrated version of the signal appropriately with sin two pi Fct and adding the cosine carrier that is cosine two pi Fct, alright so we will stop here and continue with other aspects in the subsequent modules, thank you very much.