Microwave Integrated Circuits
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Module - 07
Lecture Number - 30
Noise Figure Circles (contd.)

Hello! Welcome to another module of this course “Microwave Integrated Circuits”. We are in the week 7 module 4. In the previous module we had covered the various aspects of noise how noise originates how to characterize noise and then we also introduced the concept of noise figure and noise measure. And then I mentioned how to how to adjust or how to arrange stages in cascades so that you get the lowest noise figure overall. In this module we will be covering the noise figure circles or how to design a circle which has a given requirement of noise figure. How do we design that circuit so as to achieve a particular value of noise figure?

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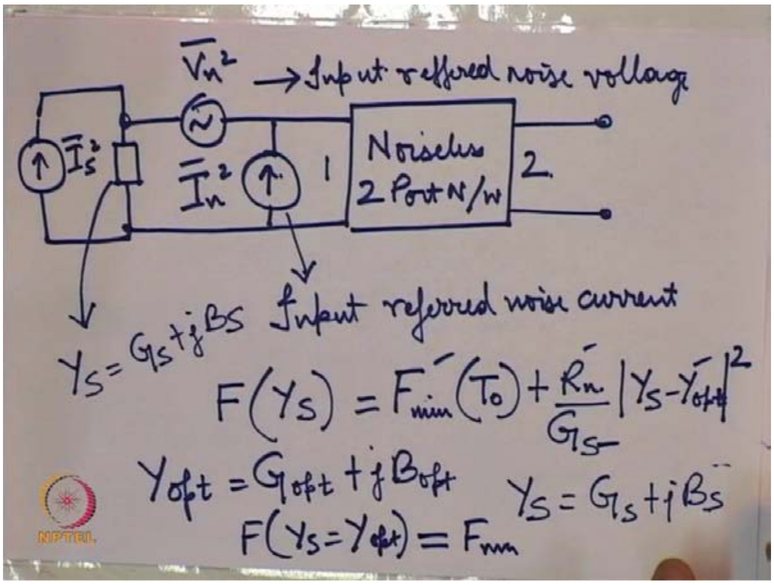

So in this module we will be just we will proceeding just like in the same way that we proceeded for the gain circles that is to design that is to design a circuit having a particular value of transducer gain, unilateral case or the operating power gain of the available power gain. So let us let us see how to how to obtain these noise figure circles. So the first aspect is that we have our two port network. This is power two port network and if we consider it to be a noise less circuit, so this is our noise less two port network and so what we have is two aspects of two quantities which have to be extracted.

The input referred noise voltage and the input referred noise current so this is port 1 and this is port 2. Now suppose we have a noise source here it is a current source now it can be shown that… Now suppose this is our entire arrangement this is our input ka noise current source, this is the impede or admittance of this noise source this at the V N square and I N square of the input referred noise and noise voltage and noise current.

Then it can be shown that the noise figure for particular value of YS is given by where we have this Y opt is equal to G opt plus JB opt so what we have is 1 2 3. There are 3 quantities this F mean RN and Y opt if we know these three quantities then we can completely characterize the noise associated the noise (asso) noise figure associated with a two port network. Now GS here is given by this YSs is given by GS plus JBS so it is the real part of YS.

So there is what this means is there is an optimum value of YSs for which we obtain F mean T, F mean that is FYS equals to Y opt is equal to F mean. This T is an argument just to emphasize that noise figure is a function of temperature.

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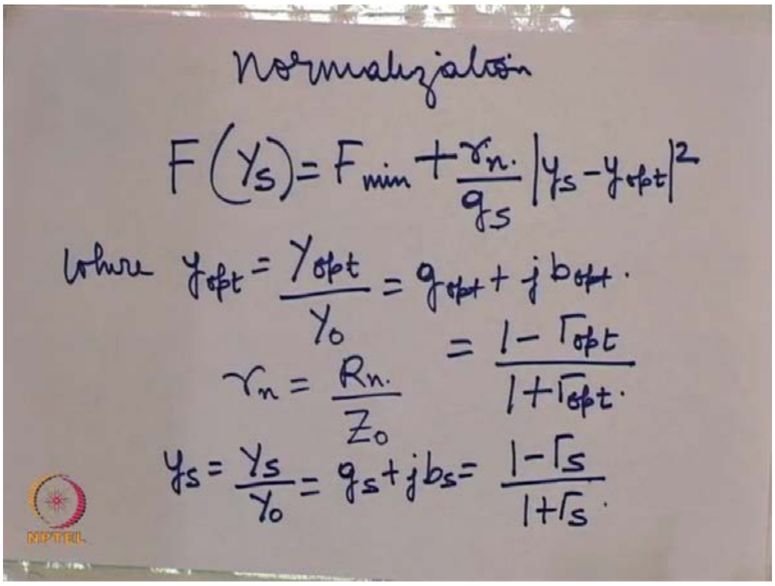

Now this equation can be rewritten in terms of the normalized values like this. Now here I am not writing the argument Y argument T where small Y opt is equal to Y opt on Y 0. RN is equal to now this small Y opt can also be written in terms of the reflection coefficient gamma opt like this. Now and this YS is equal to YSs upon Y 0.

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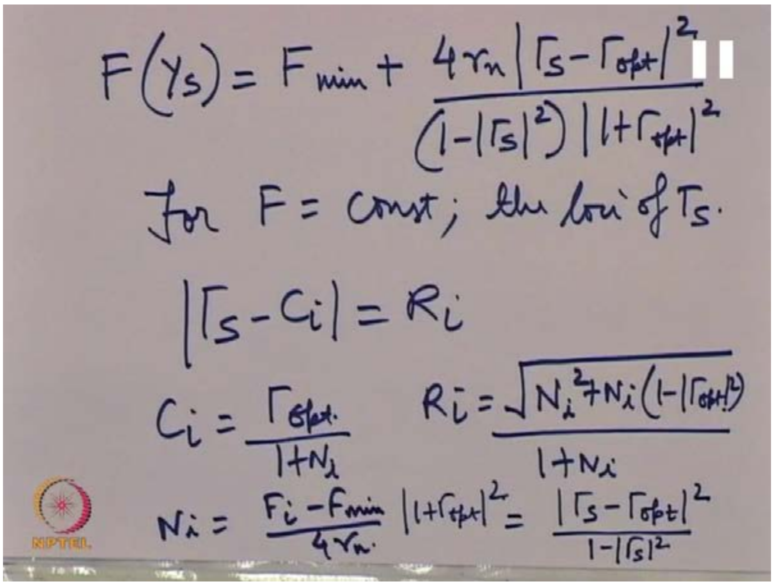

Now this noise figured f can be written as…Now it can be shown that for a contestant noise figure F is equal to constant the locus of gamma S will be given as and then this RI is given by like this… which this NI is given by this relationship and we can show this is like this.

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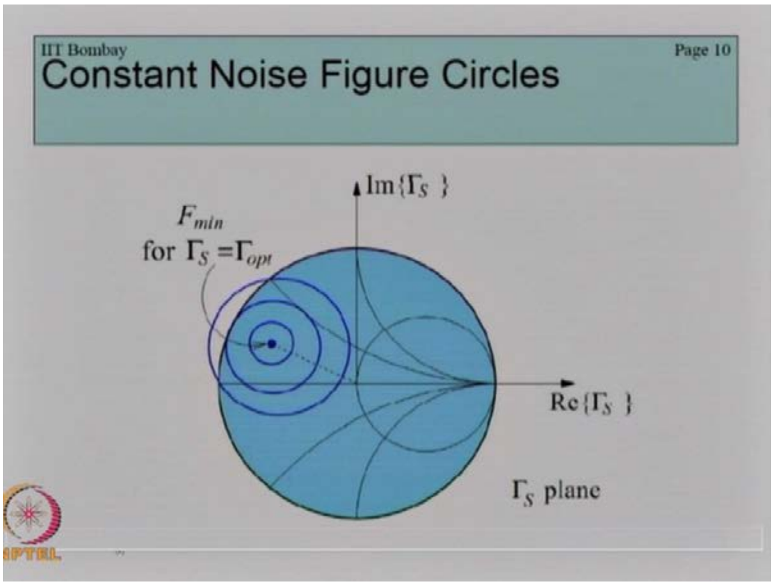

Now if we plot these curves these noise figure circles then we go to the slides on the monitor, these are the circles this the gamma S plain and we know that gamma S plain is related to the available power of gain.

Because when we design a circuit using the available power of gain circle we are in the gamma S plain and you can see that for gamma S equal to gamma opt that is for YS equal Y opt the radius of these circles is 0.

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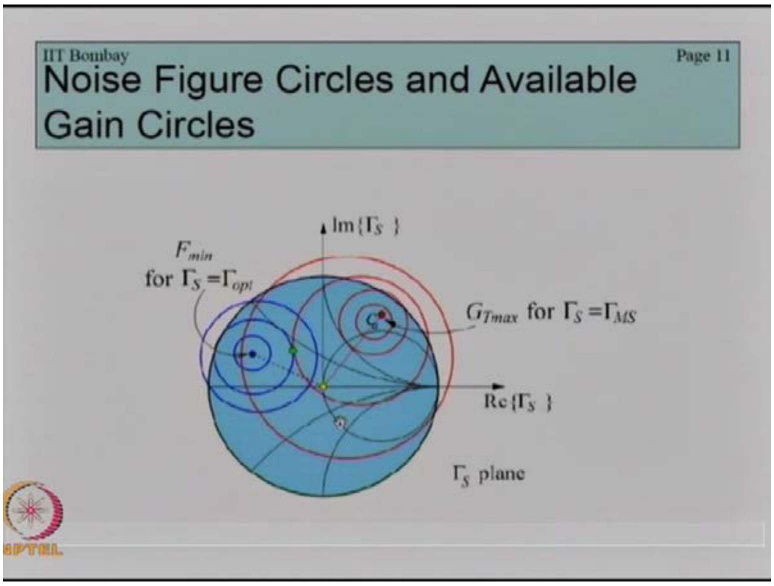

For other values of gamma S radius that is as the difference between gamma S and gamma YS, I beg your pardon gamma S and gamma opt increases the radius of these circles increases. So as I was saying that this is the gamma S plain and we can draw the available power gain circles. Now we know that the center of the available power gain circles lie on this line joining the origin with CA and the radius for gamma S equal to gamma MS that is the bilateral solution of the transducer gain, at that point we get GA equal to GA max equal to GT max and at that point the radius of these available power gains circles is 0.

Now if we want to satisfy both the available power gain requirement and the noise figure requirement then we choose a point where, suppose this is the available power gain circle we want to we have and this is the noise figure circle we what the desired noise figure. And the point of intersection between the 2 will give the solution for both the noise figure and the available power gain.

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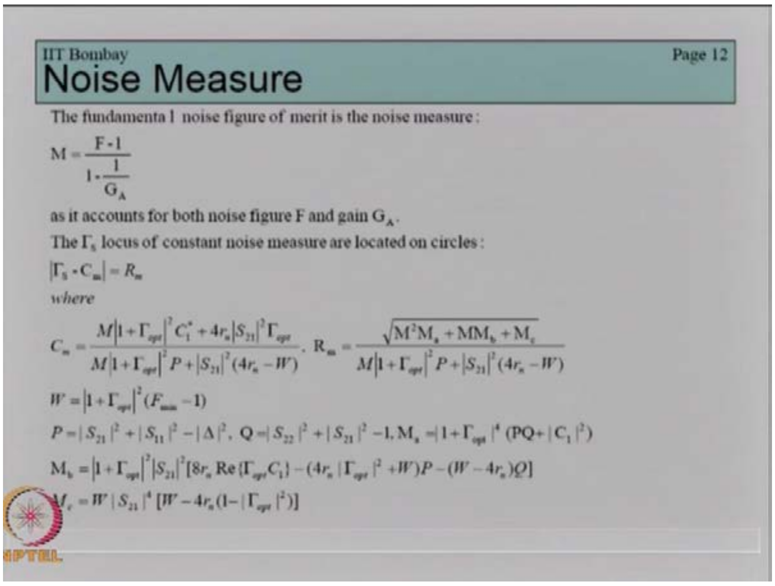

In the same that we can you know draw noise figure circles we can also draw noise measure circles and I don't want to go too much into these noise measure circles but they are useful sometimes.

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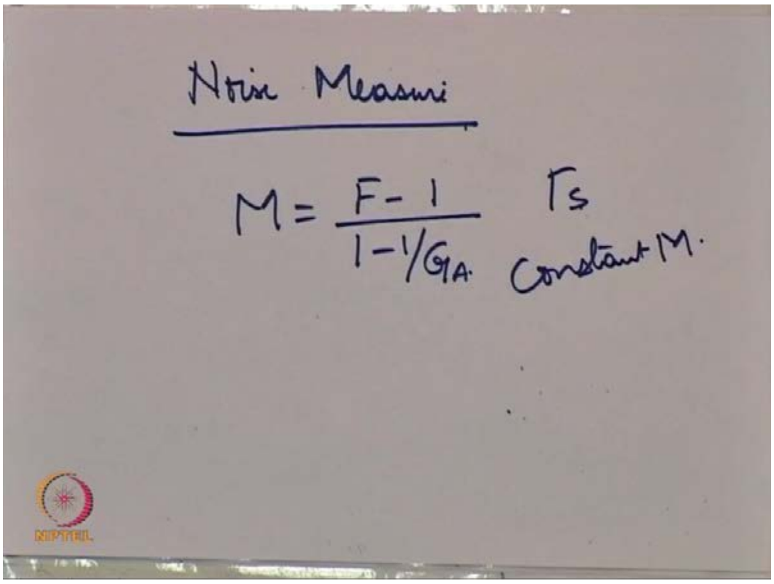

So if we come back to the slides on the written slides you know just like so noise measure of a stage is defined like this. So though not very common but these for a constant noise measure not very useful especially for single stages, but we can have noise measure circles where we trace the locus of gamma S for a constant M.

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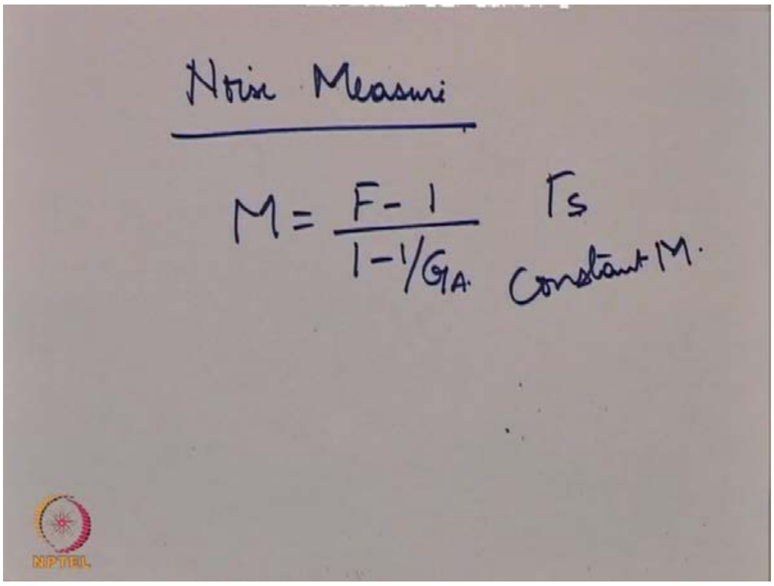

And if we go to the slides on the monitor so here we can some sample noise measure circles which have been plotted these red circles and just like the noise figure circle, we also have something called Optimum Termination for optimum for minimum noise measure.

So in summary so if we just want to summarize this module in this module we learnt about the noise figure circles, we saw that there are 3 quantities which are needed to characterize to write an equation for the noise the figure of a of a stage 2 port network.

One is the Y opt F mean and the RS RN. And we saw how we can draw this noise figure circles and how we along with the available power gain circles we can obtain optimum values of YS to satisfy both the available power of gain requirement and the noise figure requirement. Now this is a technique that is frequently used whilst designing low noise amplifiers. The derivations though I have not shown for how we got that equation for the noise figure the derivations are given in the book by Gonzales. I urge you to go through it once.

Thank you!