Analog Electronic Circuits
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Lecture no 17
Module no 01
High Frequency Response of Small Signal Amplifiers (Contd)

This is the 17th lecture and we are going to continue on High frequency response of small signal amplifiers. If you recall the equivalent circuit of a common emitter amplifier at high frequencies was drawn yesterday like this.

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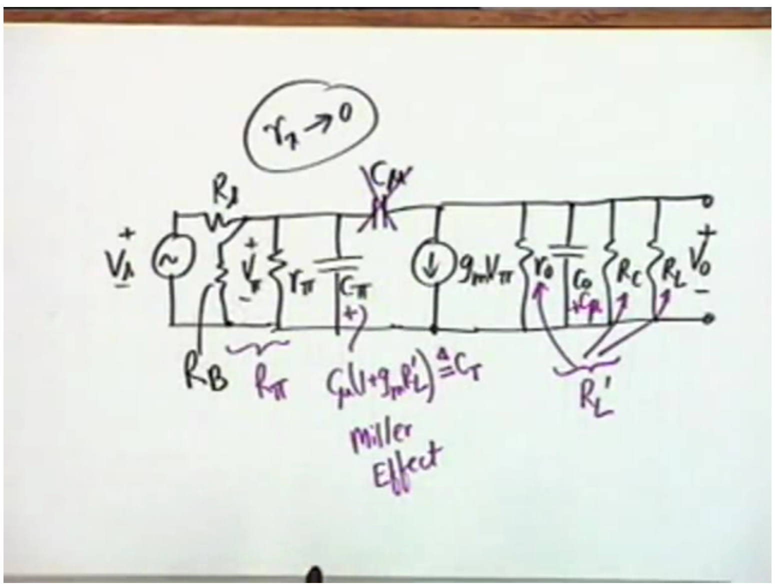

V s, R s, you have you ignored small r x so you had r Pi, C Pi and this voltage is V Pi, then you have us C Mu, a g m V Pi, finally and R 0 then C 0 and R C and R L, this is V 0, R B we have ignored, not R B, oh there is an R B oh there of course this is here R B, any other omissions?

Student: r x.

Professor: r x we have ignored, r x tends to 0 that is what we have resumed.

And we simplify R B and r Pi these 2 parallel combination we said R Pi and the parallel combination of R 0, R C and R L these 3 we called it R L prime. In addition we had shown that this cross connection for the bridge capacitor C Mu could be taken care of approximately my including a capacitance here at the input C Pi + C Mu 1 + g m R L prime, C Mu approximately reflects to the input side as this capacitance and this is due to the so-called miller affect and we had called this total capacitance C Pi + C Mu 1 + g m R L prime as C subscript T and C Mu district on the output side by adding a capacitor to C 0 + C Mu, this is an approximate miller equivalent circuit.

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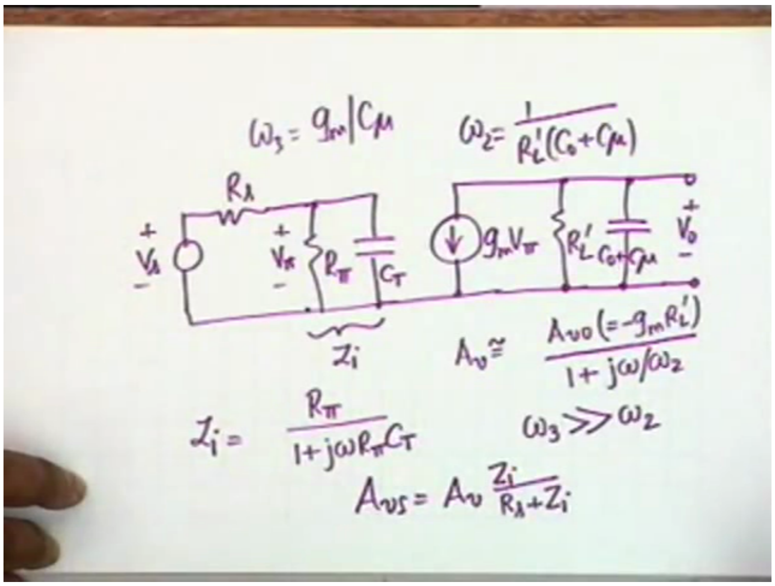

If I draw it a little more neatly yes okay now if I draw it a little more neatly it shall look like this; V s, R s, r Pi, C T, this is V Pi and then you have no more bridging g m V Pi in parallel with the resistance R L prime and the capacitance C 0 + C Mu, V 0. I would like to remind you that this simplification of C 0 + C Mu on the output side was obtained by ignoring a frequency Omega 3 which was = g m by C Mu. We saw that at frequencies around Omega 2 which is 1 by R L prime C 0 + C Mu at around his frequencies the effect of Omega 3 is negligible and therefore Omega 2 was the cut-off frequency of this output circuit okay. And we had found out that A sub v was simply = A vo, what was A vo?

Student: Energy...

Student: mid band...

Professor: Yes what is value... – g m R L prime.

This is the A v is the voltage gain between V 0 and V Pi which is same as V i okay divided by 1 + j Omega by Omega 2 and this was an approximate value under the condition that Omega 3 is much greater than Omega 2 agreed, this is just to refresh your memory how this was obtained. Now as far as the input circuit is concerned, if I call this combination as Z i, combination of r Pi and C T then obviously Z i = R Pi divided by 1 + j Omega r Pi C T agreed, therefore A vs which will be the order of A v and V Pi divided by V s okay would be Z i divided by R s + Z i agreed, this is A vs, A vs is the gain between V 0 and the actual source voltage. Z i as you can see is also the input impedance of the circuit, this is what the source with its internal resistance sees when it looks into the circuit Z i that is why Z subscript i, i is for input impedance, no longer R i it is Z i okay.

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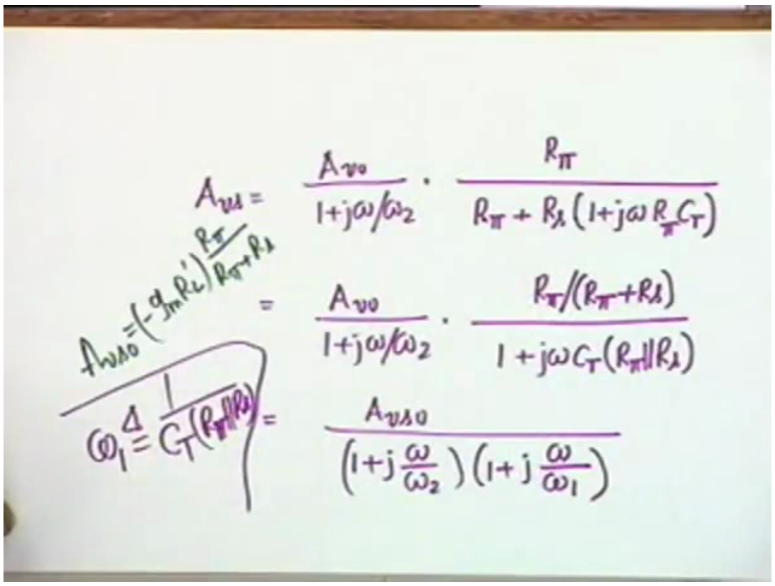

Now if I calculate this, A vs would be = A v0 over 1 + j Omega by Omega 2 and then Z i divided by R s + Z i this would obviously be R Pi divided by r Pi + R s multiplied by 1 + j Omega R Pi C T agreed, I have simplified I have struck of the denominator of Z i okay. This I can write as A v0 divided by 1 + j Omega by Omega 2 multiplied by let me write this as R Pi divided by R Pi + R s. Then in the denominator R Pi divided by r Pi + R s so in the denominator what you will get is 1 + j Omega r Pi R s divided by r Pi + R s, which is the parallel combination of R Pi and R s, is that okay. R s times r Pi and I am dividing by R s + r Pi, I have omitted one algebraic step okay.

This I can write as A vs0 that is A vs at mid band which means that you put Omega tends to 0 so this term, this term disappears all that you are left with is A v0 multiplied by r Pi by r Pi + R s. So A vs0 is the product of let me write it down; A vs0 = – g m R L prime that is A v0 multiplied by R Pi divided by r Pi + R s that is it okay. And divided by 1 + j Omega by Omega 2 multiplied by 1 + j Omega by Omega 1, you define a new frequency Omega one which is the reciprocal of C T multiplied by r Pi parallel R s so Omega 1 is defined as 1 over C T r Pi parallel R s okay, let me clear this expression write it again.

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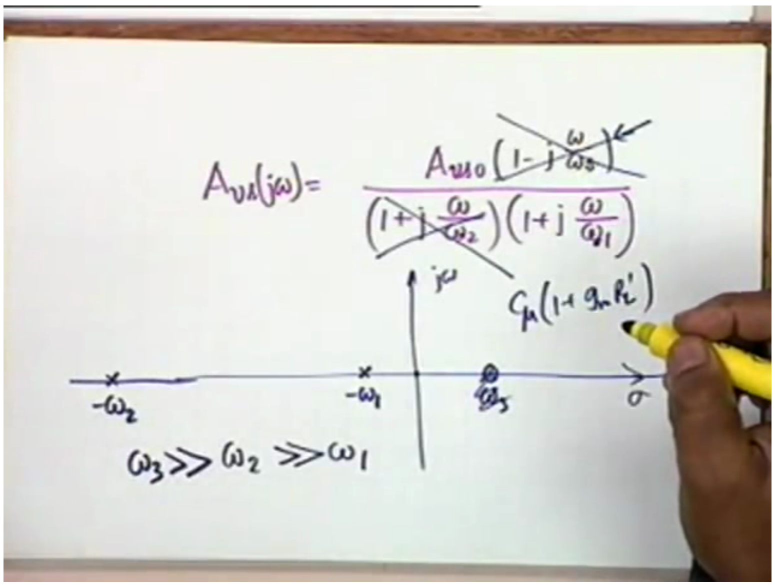

A sub vs a function of j Omega = A vs divided by 1 + j Omega by Omega 2 multiplied by 1 + j Omega by Omega 1. Actually we should have a 1 + j Omega by Omega 3 also in the numerator but Omega 3 we have ignored because Omega 3 is much greater than Omega 2. Now we shall show, okay you see that there are 3 such factors; 1 + j Omega by some constant okay or 1 – J, actually the numerator it was 1 - j Omega by Omega 3, is not that right in the numerator if you recall g m – j Omega C Mu so it was 1 – j Omega C Mu by g m, there is a '-' sign there but these 3 factors corresponds to the capacitances because there are 3 capacitances in the circuit normally you expect that there shall be 3 such factors; 1 + j Omega by Omega 1, j Omega by Omega 2, either + or minus, it can occur in the numerator it can occur in the denominator alright, 3 capacitors so 3 terms like this.

Do you also recall poles and zeros? Okay, naturally this function has 2 poles okay at S = j Omega is to be replaced by S so S = – Omega 2 and S = – Omega 1 and if I had included the other term, the term that I had ignored 1 – j Omega by Omega 3 there was a term like this, you see that the pole-zero diagram is like this. Sigma j Omega pole zero diagram, one is a 0 at S = Omega 3 okay due to this factor, there is a pole at S = – Omega 2 somewhere here a pole is denoted by a cross and the pole at – Omega 1. I have intentionally shown Omega 1 closer to the origin than Omega 2, we shall indeed show that Omega 2 is usually much greater than Omega 1.

Student: (())(13:36)

Professor: No.

J Omega is to be replaced by S if I find this is a function of small s Laplace variable, A vs of small s would be 1 - S by Omega divided by + S by Omega 2, 1 + S by Omega 1 so the poles are at S = – mega, – Omega 2 and 0 will be at S = + Omega 3 okay. I have shown Omega 2 as far away from the imaginary axis from the origin than Omega 1 and this is in general true, Omega 3 unfortunately I have shown it here but Omega 3 should have been somewhere here okay Omega 3 is much larger than Omega 2 that means this distance would be much larger than this distance okay. So Omega 3 is much larger compared to Omega 2 and Omega 2 is much larger compared to Omega 1, these are the 3 relatives values we shall take an example to show that these are approximately valid.

But you say we have ignored this, now if Omega 2 is much larger compared to Omega 1 then naturally Omega 1 is the critical frequency which will determine the frequency response of the amplifier, in other words if this can also be ignored at frequencies around Omega 1 then naturally this is again a low pass filter 1st order low pass filter that is effects of C 0 + C Mu okay the effect of C Mu, C Mu determines Omega 3 they are all swamped by the effect of C T, C Pi alone cannot do it, C Pi is comparable C Pi is of the order of 10 puf, C 0 could be 5 puf okay 1 is double the other but C T swamps everything, C T is C Pi + C M Miller capacitance and it is the Miller capacitance which swamps everything else. Miller capacitance is C Mu although a small quantity, it gets magnified by 1 + g m R L prime the mid band gain okay.

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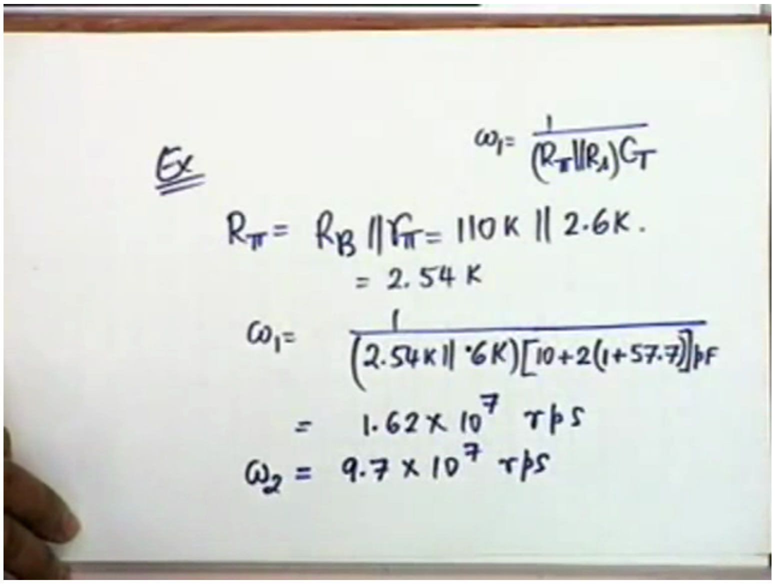

So our approximate 3 dB cut-off frequency high frequency 3 dB cut-off would be Omega 1, which is 1 over r Pi parallel R s times C T okay Omega 1. Now let us take an example, for the example that we have been considering, r Pi is R B parallel r Pi, what was R B? 220 K and 220 K so it is 110K parallel r Pi was 2.6 K and this = 2.54 K. So Omega 1 = 1 over 2.54 K parallel R s is what was R s, 600 ohms that is what we took R s so 0.6 K okay multiplied by now C T, C T is C Pi 10 puf + C Mu, C Mu was 2 puf multiplied by 1 + g m R L prime which was calculated earlier as 57.7, we did calculate this so many puff and this works out to 1.62 multiplied by 10 to the 7 radiance per second.

Recall that Omega 2 was calculated as 9.7 times 10 to the 7 radiance per second, now this value obviously is not much larger than 1.62, it is about 6 times okay, are we justified in ignoring Omega 2 when Omega 2 is only 6 times, there is a justification. I told you that in electronics much greater than means a factor of 10, this is not even 10 this is 6, how come you can justify ignoring this, justification is as follows...

Student: Square.

Professor: Square that is right.

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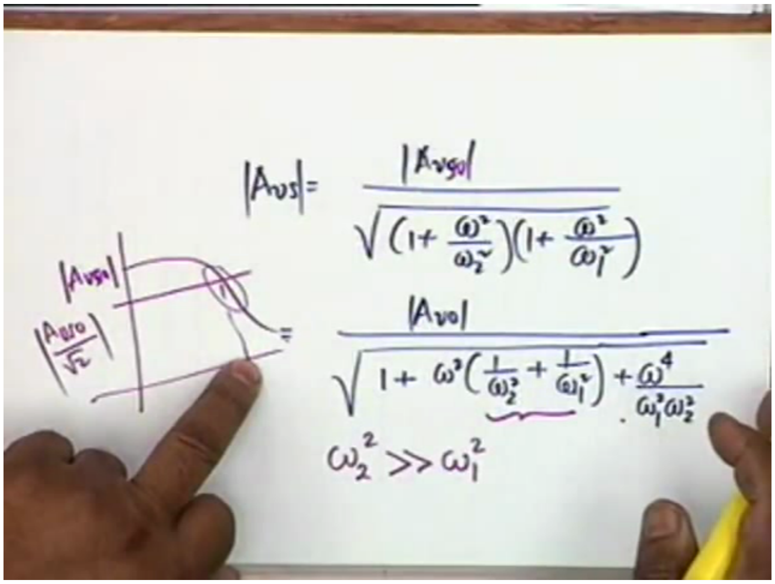

You see what happens is, if I write A vs as = A v0 the magnitude, magnitude divided by square root of 1 + Omega square by Omega 2 square multiplied by 1 + Omega square divided by Omega 1 square alright. Now this can be written as A v0 square root of 1 + Omega square 1 by Omega 2 square + 1 by Omega 1 square + Omega to the 4 divided by Omega 1 square Omega 2 square okay. If Omega by Omega 1 is of the order of unity okay if Omega by Omega 1 is of the order of unity then this term can be ignored this term will be much smaller than this term and in this term you see the relative values are of Omega 1 square and Omega 2 square, not Omega 1 and Omega 2 by themselves. So all that you need is not Omega 2 much greater than Omega 1 but Omega 2 square much greater than Omega 1 square right, and in this case it is the ratio is 36 which is much greater than 10.

“Professor–student conversation starts”

Student: Sir could you please repeat the justification for ignoring the last term.

Professor: Ignoring the last term okay, suppose Omega is approximately the same as Omega 1, then Omega square by Omega 1 square is 1 and Omega square by Omega 2 square would be 1 over 36 which can be ignored.

Student: But this is a particular case in which Omega is in the range of Omega 1.

Professor: No, this is the range that we are interested in let me tell you why.

“Professor–student conversation ends”

What happens is it falls like this and what I want is, this is A v0 A vs0 let us not make a mistake, this is A vs0 and what we want is the frequency, this frequency at which the magnitude is A vs0 divided by root 2. Now I at above this frequency at above this frequency the effect of Omega 2 is negligible this is what I want to show, so I am finding for frequencies near the frequency which will be obviously close to Omega 1 alright. Therefore in this particular case as in other cases to come, Omega 1 square as long as it is much less than Omega 2 square, as long as it is 1 decade below Omega 2 square, you understand one decade below means ratio of 10 we are perfectly in shape we are perfectly in business, which means that Omega 1 and Omega 2 need to differ only by a factor of 3.2 agreed, square of which is approximately 10 okay.

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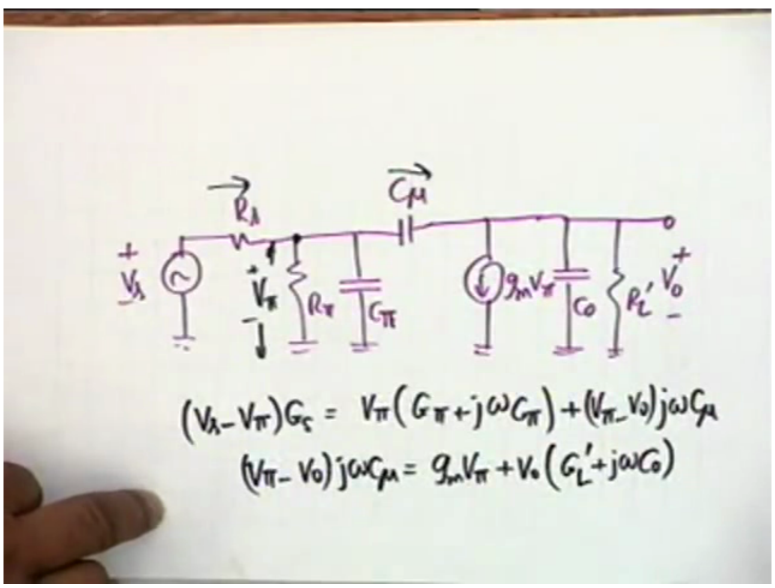

So this simplification is a great simplification and one has to use this in engineering design. Now it is also of interest now to look back and see what approximation does this affect, what kind of error does this introduce? If you recall, our exact equivalent circuit was R s, let us draw this again, r Pi, C T, okay r Pi, C T, then we have C Mu... oh I am sorry C Pi I want the exact analysis I want to find out how much error does it introduce take an idea okay C Mu then g m V Pi then C 0 and R L prime, this is our exact equivalent circuit before we took Miller effect into account alright. Now to analyse this to analyse this what one can do is to write 2 node equations that is all that is required, one is in terms of V Pi this voltage is V Pi and the other node voltage is V 0 so you have to write 2 node equations and solve for V 0 by V s if you do that and simplify, I am skipping this step...

Student: Sir we just we explained other equation.

Professor: We explained what?

Student: The node equation...

Professor: The node equation you see there are 2 V s is known, I want to find out V 0 okay, now V s and we 0 are not directly connected, they are connected through another load V Pi another load whose voltage is V Pi therefore I have to write 2 node equations, let me write this equation. V s – V Pi multiplied by G S okay this is the current that comes in, this would be = V Pi G Pi + j Omega C Pi, this is the current that goes into r Pi and C Pi + the current that goes into C Mu it would be V Pi – V 0 multiplied by j Omega C Mu agreed, this is the 1st node equation. The 2nd node equation is V Pi – V 0 j Omega C Mu it is this current that would be = g m V Pi + V 0 GL prime + j Omega C 0 that is it. These are the 2 node equations and all that we have to do now is to eliminate V Pi, so take V Pi from one equation and substitute into the other.

The expression that you get, now what kind of expression do you expect that the degree of numerator and the degree of denominator, what will be degree of numerator? 1 because I had only V 0, the degree of the denominator would be 2 so I shall have Omega square term also and their expression is this, please do write it down.

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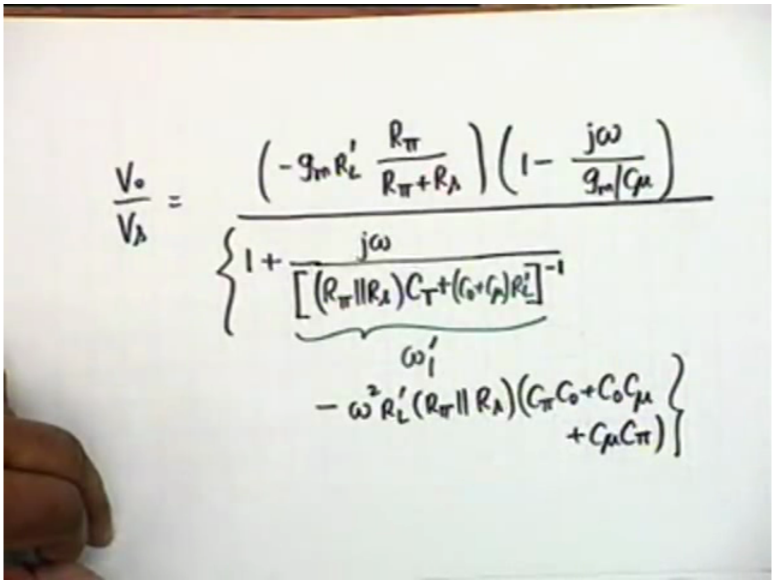

minus g m R L prime this is a V 0 as in the approximate expression multiplied by R Pi divided by R Pi + R s, this takes account of the mid band gain at the input so this whole quantity is A vs0 as in the earlier case, then we have 1 – as we have found out j Omega divided by g m by C Mu this was Omega 3 okay and divided by now here comes the difference, 1 + j Omega divided by what I get here is R Pi parallel R s times C T well it does not stop here, in the approximate expression we had simply j Omega by Omega 1 and Omega 1, I beg your pardon I made a mistake okay now it is okay alright. I have left a gap intentionally I will tell you why the gap phase, in the approximate expression it is simply this and this inverse, no this quantity was taken as Omega 1...

No no no Omega 2 is different Omega 2 comes in 1 by R L prime C 0 + C Mu, this inverse was taken Omega 1. In the exact expression there is in addition a term which is C 0 + C Mu R L prime that is the term which contributes to Omega 2 also occurs here, and it is quite understandable because even in the approximate expression the coefficient of j Omega should have been 1 by Omega 1 + 1 by Omega 2 approximate expression, in the exact expression the 2 add to each other okay so this we shall call Omega 1 prime, it is not quite Omega 1 it is Omega 1 modified Omega 1 and then you have an Omega square term and this square term is like this, – Omega square it is still in the denominator R L prime R Pi parallel R s multiplied by C Pi C 0 +

C 0 C Mu + C Mu C Pi this is the expression okay, normally it should have been Omega square divided by Omega 1 square multiplied by Omega 2 square in the approximate expression.

Student: This is the denominator?

Professor: This is all in the denominator okay this is all in the denominator.

And what we have done is we have ignored this we have ignored this which can be ignored in an actual circuit and instead of Omega 1 prime = this we have ignored this term okay and the condition, well before we say before we find out the condition under which this can be ignored let us take the exact expression and substitute the numerical values and see what sort of approximation you get.

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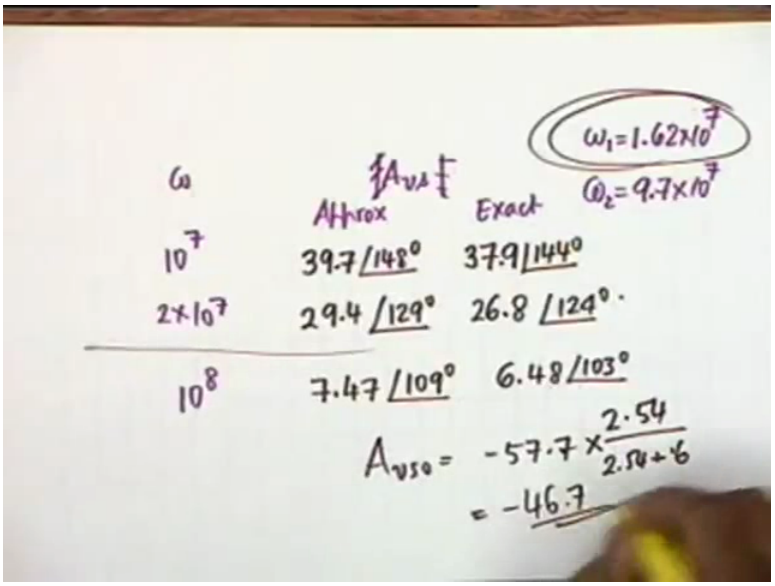

This have been calculated and the values of A vs have been found out at the magnitude not the magnitude the total expression, obviously we have to feed it into a computer and calculation would be too large. At various values of Omega, now would you give me the value of Omega 1, what did we calculate 1.62 times 10 to the 7 and what is Omega 2, 9.7 times 10 to the 7 okay, so what we did was calculate at Omega = 10 to the 7 just before Omega 1 at 2 times 10 to the 7 at 3 frequencies we calculate that is immediately after Omega 1, around Omega 1 and then at a frequency nearly = Omega to, let us we calculated 10 to the 8; 3 frequencies we calculated and we calculated the approximate value that is by using the Miller model and the exact value that is by using this horrible looking expression okay alright.

The values that we get are very illuminating, the approximate value is 39.7 magnitude and the angle instead of 180 degree, at mid band the angle is 180 degree will now become less than 180, it becomes 148 degree, it is a complex expression find out its magnitude and its phase, obviously you have to feed it into a computer okay. And the exact value comes 37.9 angle 144 degree, you can calculate the percentage but you see they are visibly good approximations okay. At 2 times 10 to the 7 do you expect the gain to be more than 39.7 or less than 39.7? Less and the value is 29.4 129 degree and the exact is 26.8 you see the error is increasing why, because you are going closer to Omega 2, if we had calculated at 10 to the 6 the error would have been much less alright, so 26.8 and the angle is 124 degree. And far away that is nearly at Omega 2 the gain is still less 7.47 the angle is 109 degree, the exact value is 6.48 angle 103 degree.

The angle does not change substantially okay between the exact and approximate you see this is 4 degree, this is 5 degree, this is 6 degree, the angle does not change substantially and 4 degree is what for 144 degree, so the percentage error is much less it is in the magnitude. Now one argue that we will not obviously use the amplifier with a gain of 7.47, when the mid band gain is, what is the mid band gain? A vs0...

“Professor–student conversation starts”

Student: 57.7

Professor: No... 57 point okay - 57.7 multiplied by R Pi, what was R Pi? 2.54 divided by 2.54 + 0.6 and this value no I have not calculated. Anyway, this value as you see it is approximately 56 okay 2.54 divided by 3.14 okay it is greater than 50, obviously we will not use the amplifier when the gain becomes 7.47, we will go approximately up to 2 times 10 to the 7 not more than that. So 3 dB cut off being taken as Omega 1 is justified even by exact analysis yes... Pardon me…

Student: It is - 46.7.

Professor: - 46.7 okay so if at mid band we require 46.7 obviously we will not go beyond let us say 30 on this side, on the lower side also there will be a decrease of gain just to be calculated later yes

Student: Sir if the frequency higher then we should have larger error between exact and approximate results.

Professor: Yes.

Student: But in this case we see that (())(35:10) 10 to the 7 as frequency, the error is more as compared to (())(35:14).

Professor: Okay that is a good point.

Student: Percentage error.

Professor: Percentage error that is what comes not the absolute error okay, you have answered the question this is like a self-interview. You know what is self-interview?

Student: No.

Professor: After the class.

“Professor–student conversation ends”

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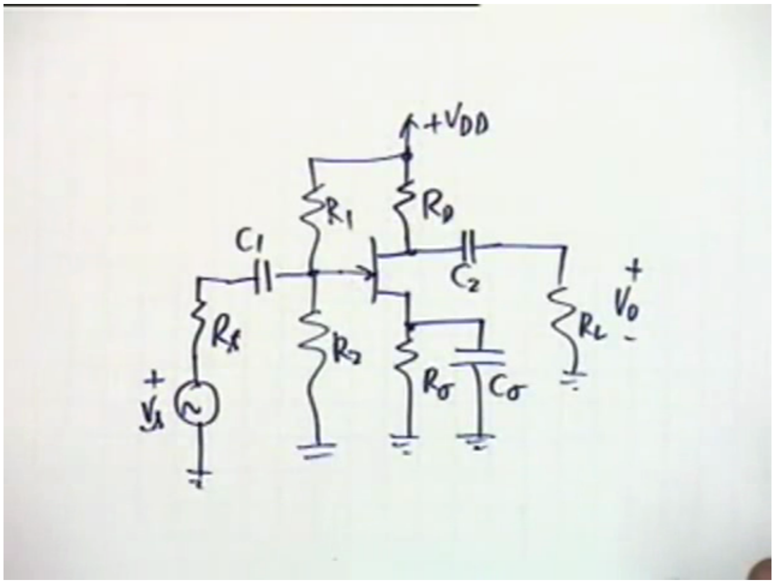

Okay now as far as an FET amplifier is concerned, the analysis is exactly similar so I shall only recall the steps in the analysis and give the results, the algebra I will not carry out. The circuit let us draw it as low harmony repetition, the circuit is V DD, R sub D, you have a drain source, the sources bypassed, the common source amplifier with C Sigma, there is a capacitor C 2 which goes to R L, the voltage is V 0 and the biasing is done by 2 resistors R 1 and R 2, the sole purpose being to establish a voltage at the gate okay, I have shown an N-channel JFET, the sole purpose of R 1 and R 2 is not to feed the current like BJT, this must be understood, BJT requires a base drive base drive not voltage but the current because otherwise I sub C shall be 0, I sub C is approximately beta times 0, but here this is not the case.

Here what we want to establish a voltage is a voltage at the gate and a voltage at the source such that V gs is negative or positive? Negative in an N-channel JFET okay and then you have the capacitor C 1, R s and V s okay this is the circuit.

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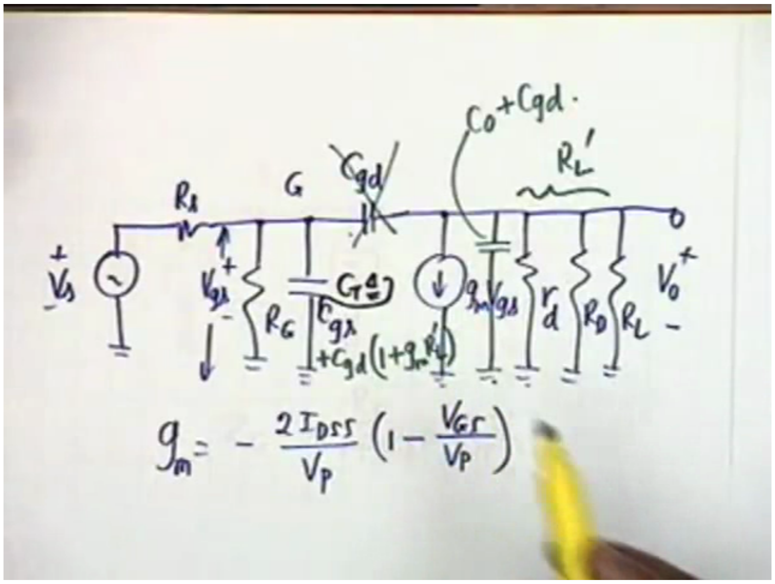

And the equivalent circuit the equivalent circuit would be V s AC equivalent circuit would be V s, C 1 is taken as short so R s, it goes straight to R sub G which is a parallel combination of R 1 and R 2 and then you have a capacitance of value C gs okay then from the gate to the drain you have a capacitor C gd and the voltage here is V gs, the current source here would be g m times V gs, where g m now has to be calculated as if I recall g m is – twice I DSS divided by V P multiplied by 1 – capital V GS divided by VP wonderful, you have to calculate this okay. Then this goes to ground what we have here? A dynamic r d dynamic drain resistance and we have the parallel combination of R D and R L, this voltage is V 0. As usual we do simplification by combining these into R L prime that is all that is not r Pi here okay.

So if I now take Miller effect into account then C gd, I have made a mistake and I am waiting for the correction... C 0 there is a capacitor here CG low and if I want it if I want to analyse this by Miller effect that is avoid this bridge, which creates complications we have to write 2 node equations if I want to avoid this then all I have to do is add 2 C gs, C gd multiplied by 1 + g m R L prime and 2 C 0 I have to add C gd okay, this is the Miller effect equivalent circuit. You want me to draw this more neatly?

Student: Yes sir.

Student: Yes sir.

Professor: Okay, whatever you want.

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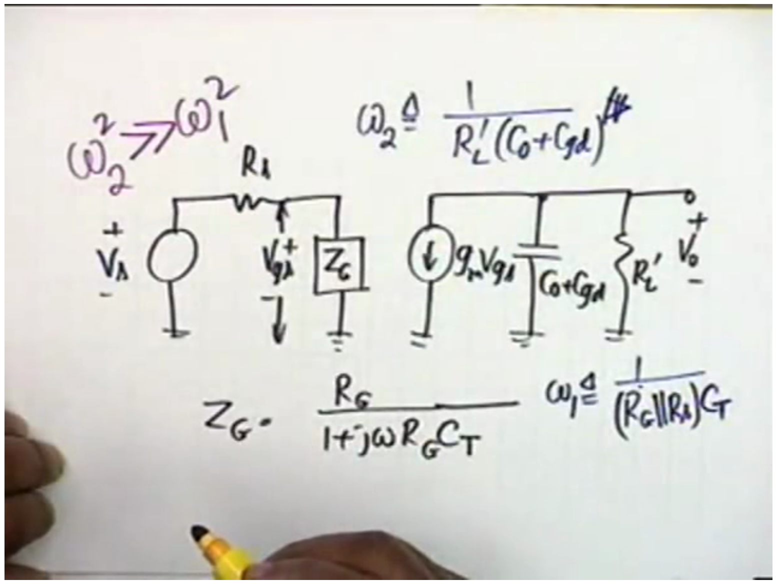

V s, R s, why do not you draw this as a Z G, what is Z G? It is R G divided by 1 + j Omega R G multiplied by C T once again this capacitance total capacitance I shall denote this by C T = C gs + C gd 1 + g m R L prime, this is V gs and then I have a g m V gs and C 0 + C gd and then R L prime, this is V 0. Naturally since we have converted 3 capacitor circuit into 2 capacitor one that 0 in the numerator we have ignored okay and there would be 2 poles now, one due to Z sub G and the other due to C 0 + C gd as in the BJT case. And as usual the same relationship would be true that is if we define let me do it in this figure itself, if we define Omega 2 as 1 over R L prime C 0 + C gd okay and Omega 1 as what? 1 over R G multiplied by R G parallel R s not forget this multiplied by C T.

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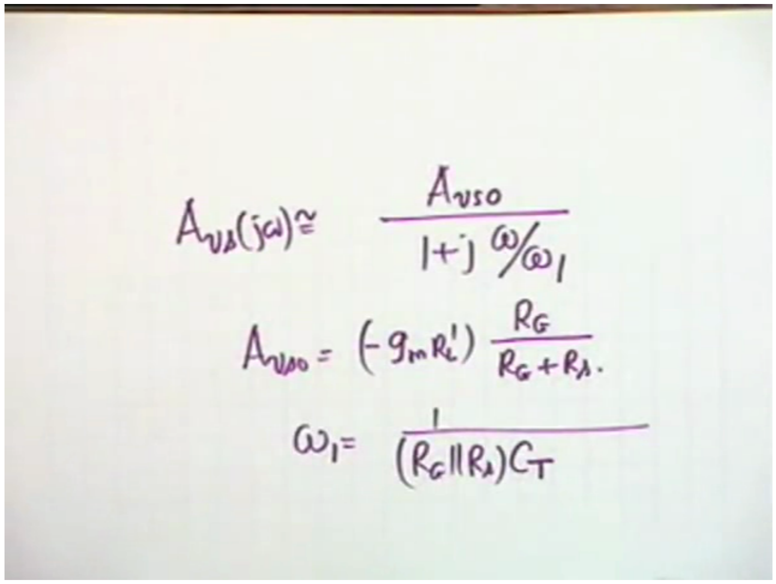

If we define these 2 cut-off frequencies these 2 frequencies then Omega 2 would be much greater... No that may not happen, what should happen? Mega 2 square let me write it in a brighter colour, Omega 2 square will be much greater than Omega 1 square so that so that our gain expression A vs of j Omega A vs of j Omega will be given by A vs0 approximately divided by 1 + j Omega by Omega 1, where A vs0 will be what the value is, – g m R L prime multiplied by R G divided by R G + R L okay, and Omega 1 is divided by 1 over R G parallel R s multiplied by C T under the usual approximations okay. Since we have done the BJT circuit in detail we did not have to do FET in details, I avoided all the algebraic steps.

Once again it is of interest to find out what kind of error, error may not be the same as in the BJT because the values of the resistances are quite different, they are different magnitude so one has to calculate the error, and if you have to calculate the error then you have to analyse the exact circuit with a 2 node analysis, 2 node equations have to be written and have to be solved, let us see if I have the expression I shall give you the exact expression but let us quickly look at one example.

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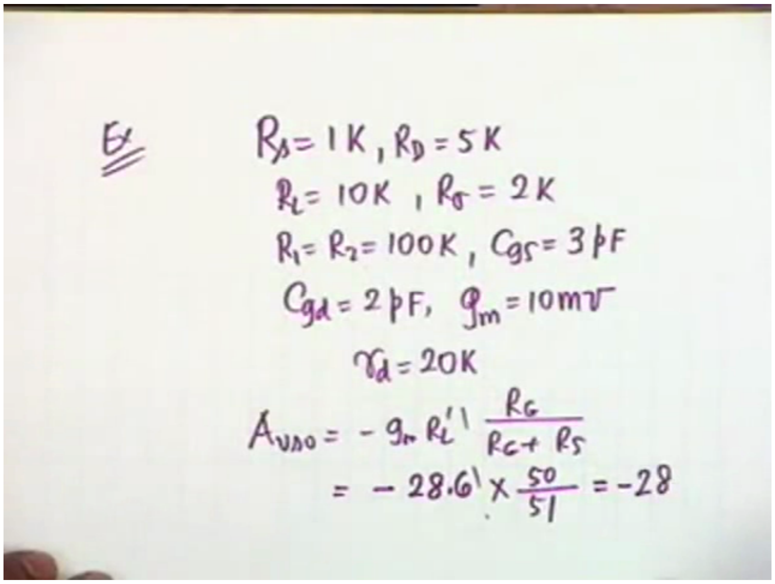

In this example we assume that R s = 1K, R s was 600 ohms in BJT why have we increased it because FETs can take higher values of source resistance why because FET input impedance is very high very good. R sub D is 5 K, R L it can take larger load also 10 K, R Sigma is 2K, R 1 and R 2 both are 100K, C gs is 3 puf, C gd is 2 puf, g m calculated from I sub D is 10 millimho typical value and r sub d is 20 K. Suppose g m was not given, suppose this was not given, could you calculate g m from this data so what do you need?

“Professor–student conversation starts”

Student: I D.

Professor: Who is going to give you ID?

Student: I DSS.

Student: I DSS.

Professor: And what else?

Student: VP.

Professor: V DD would have been needed, is not that right? We have not given that because all the parameters are given agreed.

Student: VP.

Professor: VP also that is correct. If g m was not given then you ask for 3 more data; V DD, why is V DD needed to calculate V gs come to the point VDD is needed to calculate V G alright not V gs, V G, V s would be calculated from I D, I D times R Sigma so V G – V s that you have to substitute for expression in I D and solve a quadratic, that you have to exercise your intelligence to reject one of the values; one value shall be admissible the other shall not be okay.

“Professor–student conversation ends”

Now if this is so then A vs0 is given by – g m R L prime R G divided by R G + R s, substitute these values and it calculates out to - 28.6 multiplied by 50 divided by 51, why did I calculate this separately? Pardon me... Why did I calculate this separately? This I will require for the Miller capacitance, Miller capacitance is C gd multiplied by 1 +... Now if you put this in a calculator and calculate, you will soon discover that you will have to go back calculate the g m R L prime also so it is better to calculate this in 2 steps and this becomes - 28 approximately.

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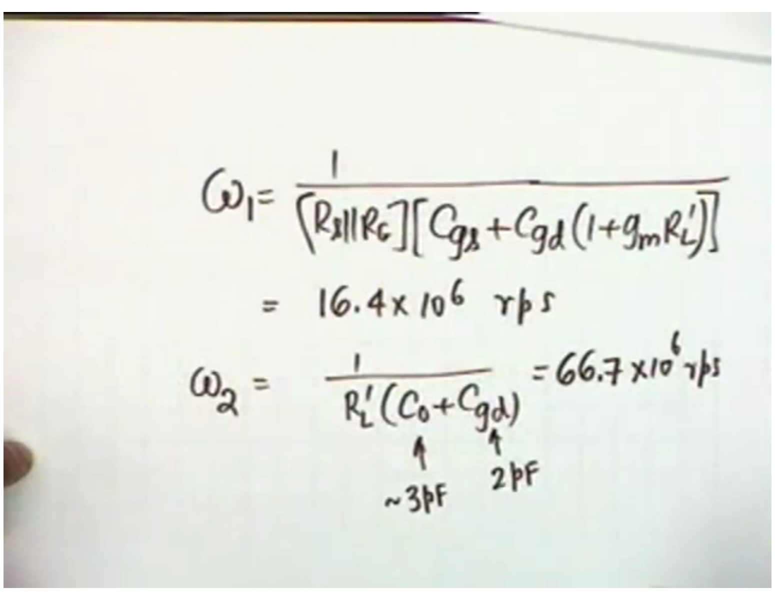

And Omega 1 the frequency Omega 1 is 1 over R s parallel R G and the capacitance is C gs + C gd 1 + g m R L prime and that calculates out after a bit of calculation to 16.4 times 10 to the 6 rps. It is of interest to know whether this dominates or not that is it is of interest to calculate Omega 2 also, Omega 2 is given by 1 over R L prime then C 0 + C gd, it has not been given what is given is C gd, how much was given 2 puf, C 0 would be comparable to C gd so even if even if this capacitance C 0 + C gd let us say let us assume it to be 3 puf, so even if this is 5 puf even if C 0 + C gd is 5 puf well if it is 5 puf then this calculates out to 66.7 multiplied by 10 to the 6 radiance per second alright, 66.6 10 to the 6 radiance per second, which is only 4 times approximately but square is 16 times so the approximation is justified. I will strongly encourage you to find out the exact expression also, to find out the exact analysis I have the expression yes.

Student: Sir how do you assume C 0.

Professor: How do you assume C 0? C 0 normally is a stray capacitance and it is of the order of a few puf, you can take slightly higher so long as Omega 2 square is 10 times, we have put a margin here right, so long as Omega 2 square is 10 times it is okay, C 0 can also be measured in the actual varying you can measure and you can reduce C 0 by careful varying okay, right any other questions?

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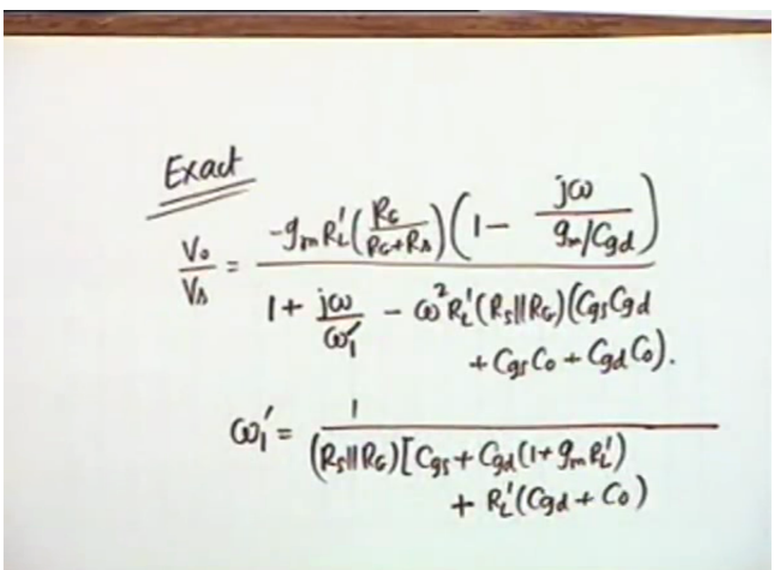

The exact expression for V 0 by V s by making a 2 node analysis is the following, write it down and try to verify that it is indeed so, R G + R s then you have 1 – exactly like the BJT j Omega divided by g m over C gd this is that Omega divided by 1 + j Omega by Omega 1 prime not Omega 1 - Omega square R L prime R s parallel R G times C gs C gd + C gs C 0 + C gd C 0 this is the exact expression. I do have some calculations regarding exact values but I think we can skip that. Omega 1 prime the only difference is R s parallel R G times C gs + the Miller capacitance that is C gd 1 + g m R L prime, in addition we have a term can you guess what this term is? Exactly like the previous case it is R L prime C 0 + C gd that is it and usually this term is negligible this term is negligible compared to previous one.

Well sure the condition under which this term will be negligible compared to this is that C gd + C 0 must be much smaller compared to g m C gd multiplied by R s parallel R G, is that point clear? No okay I want to ignore this compared to this and you know g m R L prime is much larger compared to 1 so you can ignore this and you know the Miller capacitance swamps the total...

Student: (())(53:10)

Professor: It must close here, where else can it close? It must close here okay.

We can ignore 1 and then C gd g m R L prime will swamp C gs so you can ignore C gs, what I want is that this term should be small compared to R s parallel RG multiplied by C gd multiplied by g m R L prime, you see what was the purpose of this simplification, to cross out R L prime.

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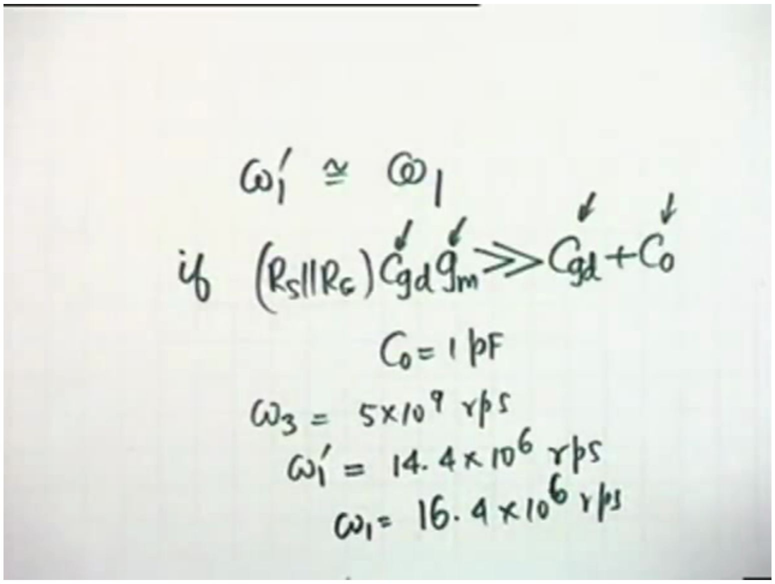

We are finding out inequality so Omega 1 prime make a profound statement Omega 1 prime is approximately = Omega 1 if R s parallel RG multiplied by C gd g m is much greater compared to C gd + C 0 okay this is the condition, no R L prime we have, there is an R L prime here there is an R L prime here so we have crossed that out, we wanted to find out independent of R L prime. You see all that is involved is all that is involved is the interval parameters of the transistor JFET, the external resistors R s, R 1 and R 2 and the stray capacitance C 0 okay, under this condition Omega 1 prime would be = Omega 1.

I have some calculation is, a looming C 0 as 1 puf for the same example as we had taken earlier, assuming C 0 as 1 puf we get Omega 3 which is g m by C gd is 5 times 10 to the 9 rps, A vs0 we have already calculated, Omega 1 prime calculates out to 14.4 times 10 to the 6 rps, what was the value? What was Omega 1? 16.4 times 10 to the 6 it is not too bad. Ignoring the 2nd term instead of 14.4 we get 16.4 it is not too bad okay, in any case in actual circuit you shall have to make adjustments so one can afford to become (())(55:59) circuit calculation electronic circuits in particular because you will have to make fine adjustments and so on and this is a good point to stop, next time we are going to talk about low frequency response.