AnalogElectronic Circuits
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Module No 01
Lecture 33: Problem Session-8 on Feedback Amplifiers

The 1st problem that we tackle, these problems are on feedback amplifiers. The 1st problem is the following.

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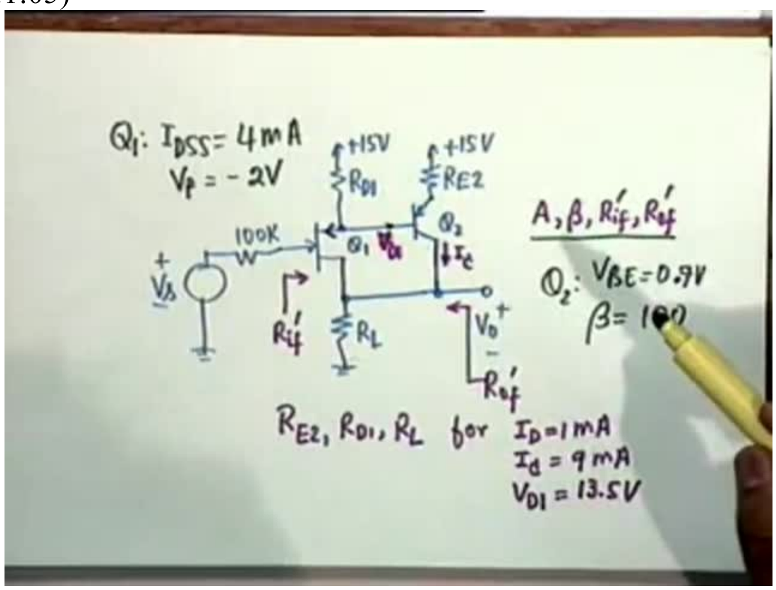

We have a source, VS. I have chosen 4 problems to illustrate the 4 different kinds of feedback architecture. The source resistance is 100 K and to bring variety into experience, we have a fet, FET goes to + 15 volts and the resistance is RD1 okay. It is not specified. And then the output of this is directly coupled to a BJT all right? It is an FET-BJT combination and the BJT is also not npn, it is pnpand the source is the supply is the same, 15 volt. There is a resistance RE2.

Do you understand why it is + 15? Because it is connected to the emitter and this is the emitter resistance, not the collector resistance okay. It is very easy to make a mistake and therefore we should be careful. This is Q2, we call this as Q1. Thesource and the collector are connected together and there is a resistance to ground here which is RL. What you have to find out is, the output is taken from here, V0. This is the circuit. It is asomewhat unconventional circuit.

What you have to find out is the input impedance here. Call this RIF prime. You have to find outA, beta, RIF and ROF. ROF prime is this. Okay. In addition, you have to find the resistor values, that is you have to find RE2, RD1 and RL such that I sub D for I sub D, that means this current, the DC drain current of the transistor Q1. It is not the same as the current through RD1. You must not make that mistake because that is a base current here okay.

For I sub D equal to 1 milliampere and I sub C which is this current, in this direction, I sub C is equal to 9 milliampere all right? And VD1, that means this voltage, this voltage to ground, VD1, DC voltage, I will not show this. I could as well show this okay. VD1 to ground is equal to 13.5volts. The transistors have the following parameters. For Q1what you need is IDSS. This is given as 4 milliampere and VP, this also you need,it is given as - 2 volts. All right?

And for Q2the given data is VBE, that is 0.7 volt. If it was not given, we would have assumed it but what we need most is the beta. Beta is 100. Okay. The problem specification clear? Nowobviously what you have to do is no order to find out these parameters, these are for AC analysis, you require the values of GM for the 2 transistors. And for this transfer, you also require the value of R pi Rpi2 all right. This is why the DC questions have to be solved 1st to find the DC operating condition, the Q point, then find the GMs and R pi and go ahead with the AC analysis.

Thesaving grace is that this voltage is given, VD 1, 13.5. If you go, see VD 1, let me write this equation. I have no more space here. So I must change.

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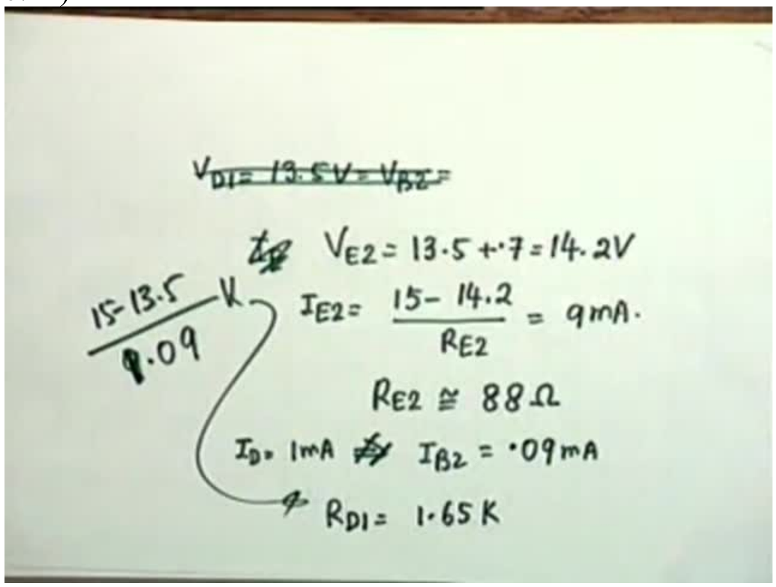

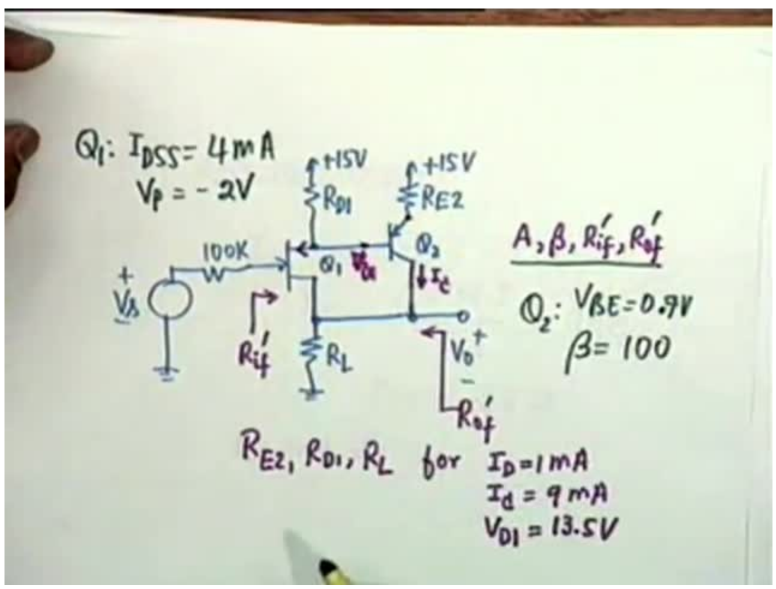

You must keep on looking at the circuit. VD 1 which is 13.5 volt is the same as VB 2 which is equal to VB2.

Student: (())(6:41)

Professor: No, we do not want to do that. We want to find out.

Student: RE2.

Professor: yes, we want to find out …

Student: We have to find out RE2 because IC is 0.7 volts so.

Professor: That is right. I wanted to find out IE2 1st which is the same as RE2, that is correct.

You see, IE2. Hold it, what is VE2? This voltage. This is 13.5+ 0.7, this is the point that I wanted to make. Do not make a mistake. It is not - because it is a pnp transistor. So 13.5 + 0.7. Now we are in business. This is 14.2 volts. And therefore, IE2 which is equal to 15 - 14.2, the supply divided by RE2 and this can be taken approximately as 9 milliampere. If you are very fuzzy, then you divide 9 milliampere divided by.

Student: Beta.

Professor: Alpha, not beta. Alpha which is beta divided by beta + 1 and but since beta is 100, we can ignore that.

Therefore, this is equal to 9 milliampere. And from which, RE2 comes out as approximately 88 ohms. I have made some rounding, just to make a quick calculation, just not to spend more time on the calculator. So there may be a small differencein the 2nd place of decimal. Next, I sub D is given as 1 milliampere which means, I sub D is given as 1 milliamperes andIB2, youlook at this. This isI sub D and IB2 would be 9 milliampere divided by.

Student: beta

Professor: beta. And therefore IB2 is 0.09 milliampere and my equation would be, to find RD1, that 15 - 13.5 divided by the total current through RD1 which is ID +IB2. And therefore RD1 can be found out. Let me not write the equation. I have explained what it is.RD1 is 1.65 K. This is what I find. What I did was 15 - 13.5 divided by 9 milliampere and 0.09.

Student: 1 milliampere

Student: Sir, 1 milliampere

Student: Sir, 1 milliampere

Professor: 1.09 milliampere. So many k which is equal to RD1. Pardon me.

Student: Sir, (())(9:55)

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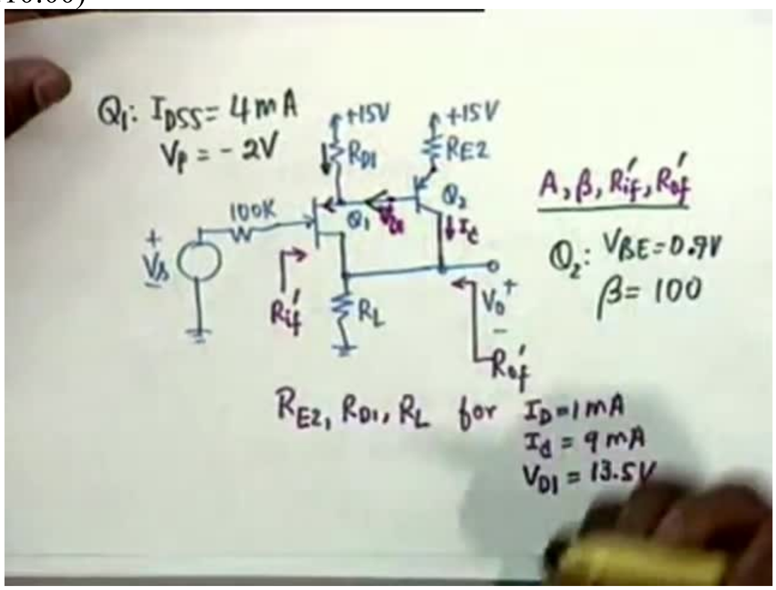

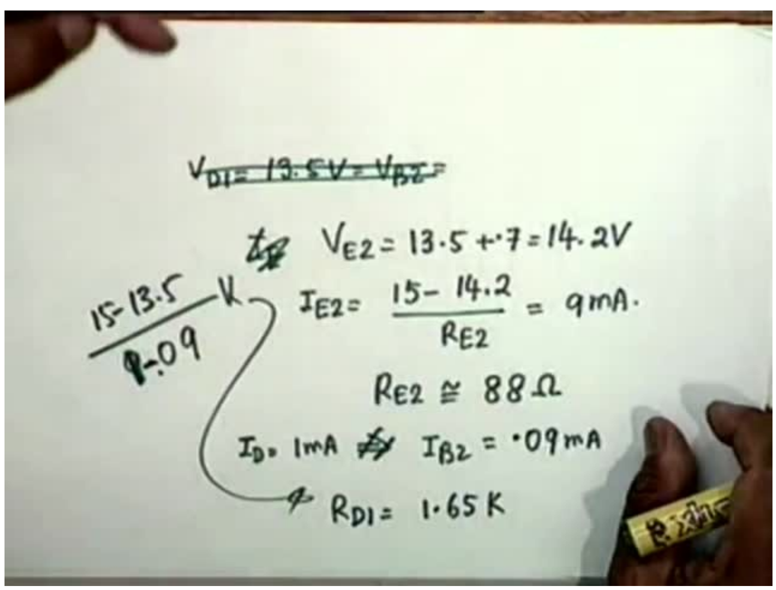

Professor: IB is in the?

Student: Opposite direction.

Professor: Oh, how wonderful? That is right. Therefore, I have made a mistake. Okay. So it should be IB, I beg your pardon. I this current would be

Student: ID -…

Professor: ID?

Student: ID - IB2.

Professor:- IB2. Okay. So it would be 1 - 0.09.

Student: Excuse me Sir.

Professor: yes.

Student: Is there any specific reason foR0 neglecting the base current?

Professor:Is there any specific reason foR0 neglecting the base current? Well, we do not know because the base current may be comparable to the drain current of the previous amplifier. You see I can neglect the base current if I compare it withI sub C. Right? But the base current is being compared with the drain current here. Okay. It may not be negligible. For example, it is 1 - 0.09 which is 10 percent. No, not 10 percent. How much is it? Approximately 1 percent.

Student: 9 percent.

Professor: 0.0, a 9 percent. 9 percent obviously cannot be ignored. We will not ignore this okay. Anyway. So you understand where one can make mistakes. In the sign of VBE,in the direction of the base current. All right.

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11:48

If we cross these hurdles, the last thing to doout is to find out, this is not a simple problem although itlooks very simple. You have to find out RL and obviously, for RL, yourequire VGS. Because the equation forI sub D is IDSS 1 -

VGS by VP whole square. And VGS can be written in terms of ID. So it would be an implicit, no it will not be. Let us see.

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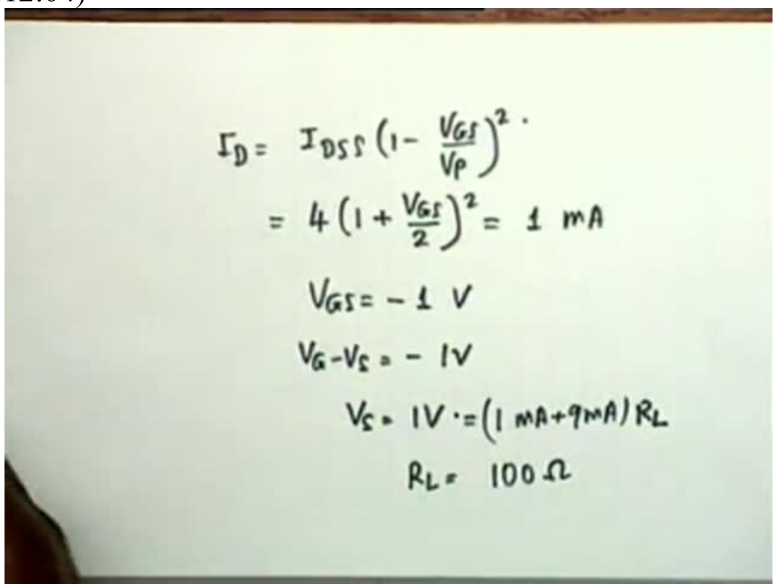

OurI sub D is IDSS 1 - VGS by VP whole square. You are used to getting implicit equations in ID, aquadratic equation. This will not be the case here because ourIDSS is given as 4 milliampere, 1, VP is equal to - 2. So 1 + VGS by 2 whole square and this is given as 1 milliampere which makesVGS equal to - 1 volts. Is not that right? Now VGS is VG - VS which is - 1 volt. And if you look at the circuit, what is VG? What is the volt, DC voltage here? There is no source, there is no DC source. Therefore it is 0. Is that clear?

So VG is equal to 0 which means that VS is equal to 1 volt. Now what is VS? VS is this current + this current, IC + ID into RD okay. So this is 1 milliampere+ 9 milliampere multipliedby, this is the current flowing through RL. Therefore RL is equal to 100 ohms, correct. So you have found outall the parameters. Agreed? Now after you have found out the 3 resistances, the currents are given. 1 milliampere, 9 milliampere, okay. Now after we have found out these, we can now go to the AC equivalent circuit and we will not draw the AC equivalent circuit, we will draw the A circuit and the beta circuit right by looking at the given circuit okay.

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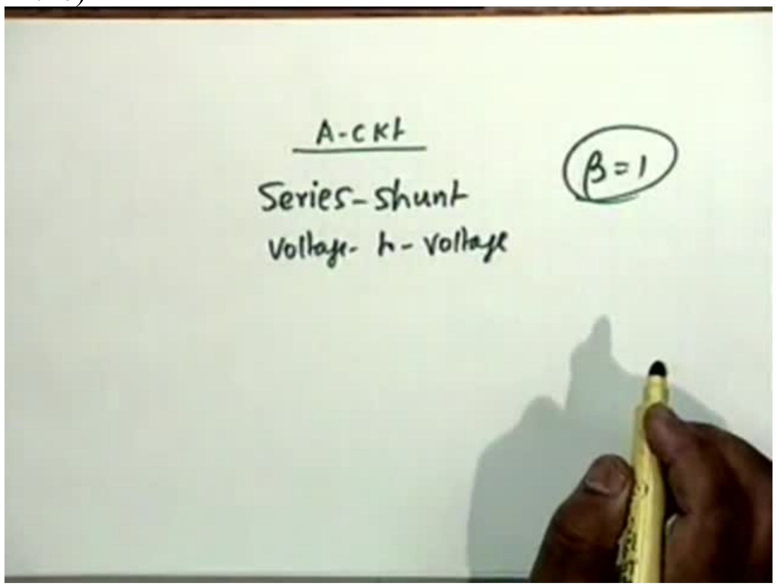

For the A circuit for example, this is where you will have to pay attention. Now 1st thing is, you have to identify the kind of architecture because the A circuit shall have to be drawn in the proper model. Proper model whether it is a voltage to current, voltage to voltage, current to voltage or current to current. Now what is this connection? Obviously the input connection is series, the output connection is?

Student: Shunt.

Student: Series.

Student: Series.

Professor: No.

Student: Shunt.

Professor: It is shunt because the output voltage is taken here. The voltage is being directly fed and therefore this is a shunt connection.

Student: Sir, please explain.

Professor: Please explain. The output, if the output voltage was being taken here then it would have been a series connection here.

Student:R pi (())(15:11)

Professor: Not, it is not the question of R pi. Where it is connected, the fed feedback voltage, VF, is it proportional to the current through the load or the voltage across the load? It is obviously is exactly equal to V0 and therefore there can be no question. It is a shunt connection. It is also obvious that beta in this case, we do not have to do anything. What is beta?

Student: 1.

Student: 1.

Professor: Beta is 1 because V0 prime will be equal to VF prime. There is only a shunt resistance across it.

So one thing we identify immediately is beta I equal to 1 and the connection is series-shunt. Now in series-shunt, what should be the model of the amplifier that determines the drawing of the A circuit. What should be the model of the amplifier? Voltage to?

Student: Current.

Student: Current.

Professor: No.

Student: Voltage to voltage.

Professor: Voltage to voltage. Do not make such mistakes. This is a voltage to voltage and therefore capital A shall be found as voltage ratio and therefore I do not have to convert the source into a Norton one okay. So my circuit is the following. Let me draw it on a separate sheet.

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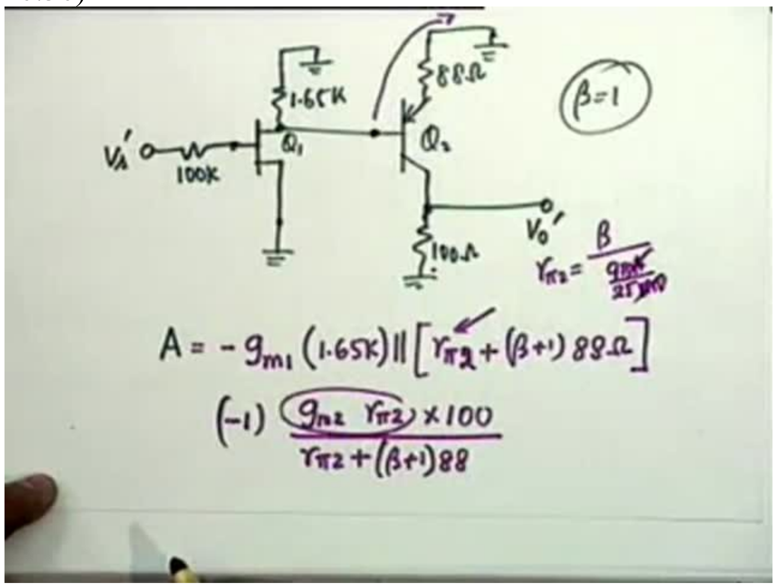

Pleasecheck with your original circuit. Ihave always used these primes to find the A circuit okay. There is a 100 K resistance, then we have this, now what will come here? Q1, at the source terminal of Q1, there was this RL which is part of the feedback network. Since the output is a shunt connection, we short this to ground. Okay. The A circuit. Then of course, we have the 1.65 K which we found out, this goes to ground and then this voltage goes to Q2, the pnp. Now what will be here? Since this connection is series, we have to open that. Therefore, all I will get here is 100 ohms.

And the output voltage is taken here. This is V0 prime. Q2 is connected to, we found out an 88 ohm resistance which goes to ground. And beta we have already found out to be equal to 1. Therefore, now I want you to calculate the gain A.

Student: Sir please explain why RL was grounded.

Professor: Why RL was grounded? Because the output is a shunt connection. Shunt means short. Shunt has to be shorted and therefore RL was shorted for this, RL was open for this.

Input connection is series, so it was open. It is a series-shunt okay. Now I want you to calculate the gain by inspection. Ifgo from here to here okay, as far as this point is concerned, there is no drop. So this is also VS prime. Agree? Because the input is open. It is a JFET, therefore the input resistance is infinity. Therefore, from here to here, voltage it would be - GM of this transistor, GM 1 multiplied by 1.6 5K parallel, the impedance coming from here to ground, you have to go via this, not via this. Is the point clear?

Student: No Sir.

Professor: No. I have to go from here to ground. I do not know the resistance between the base and the collector. I have to go via base and emitter and therefore I have to follow this route.

That is what we do for npn. Why not for pnp? Okay, what would this be? This would be obviously R pi2 + beta + 1 if you are fussy. Okay. Beta + 1 times 88 ohms. This is the gain of the 1st stage. Now the gain of the 2nd stageyou see you have a resistance here as well as here approximately, it would be 100 by 88 but let us calculate exactly what it is. It would be - okay. How do I take care of this? - 1, let me multiply by this for the 2nd stage, Q2.

It would be - GM2 times V pi2 okay.GM2 times V pi2 which would be R pi2 divided by, okay divided by R pi 2 + beta + 188 ohms okay. This is the current, this current flows through 100 ohms to make V0 prime, therefore I have to multiply by 100. Is that clear? I have written this by inspection. I did not draw an equivalent circuit. Ifit proves to be difficult to see, to observe, then you draw the equivalent circuit. You draw the equi so that you do not make a mistake. But with experience, you should be able to do this by inspection.

Now in this in this, all that is, you see I do not have this quantity is beta2 which is known. But Irequire an R pi2 becauseR pi2 occurs here as well as here. And therefore, I will calculateR pi2, that is not a problem. Beta divided by GM2 which isI sub C, how much?

Student: 48 ohms.

Professor: 9 milliampere. Okay? 9 milliampere divided by 25 volts. So it is 2500 by 9. So many ohms.

Student: 25 millivolts.

Student: millivolts.

Student: millivolts.

Student: millivolts.

Professor: 25 millivolts, yes. Millivolts and milliampere shall cancel and that is why it becomes 2500 by 9 ohms. Substitute this and make the numerical calculation. My calculation. Oh no, I still have something else to do. I have not found out GM1 okay?

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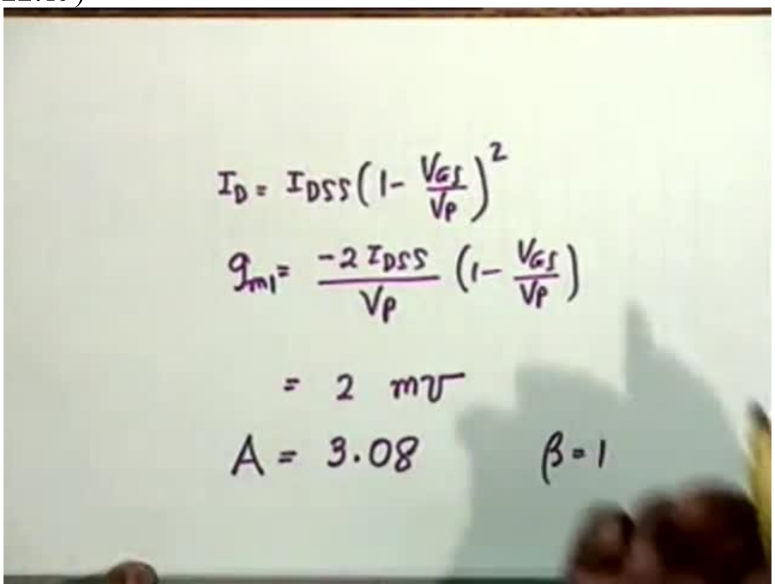

I have to go back my equationI sub D equal to I sub DSS 1 - VGS by VP whole Squaredand I find GM as - 2 IDSS byVP, you do not have to remember this formula. All that you have to remember is this one that there is a square. Thedifferentiation is obvious, multiplied by 1 -VGS byVP. And if you substitute this, if you substitute the values, my value comes as 2 millimho. And therefore, capital A after substituting this, I am omitting some number crunching. Capital A my value comes as 3.08and beta is 1. Therefore everything else falls into place. Agreed?

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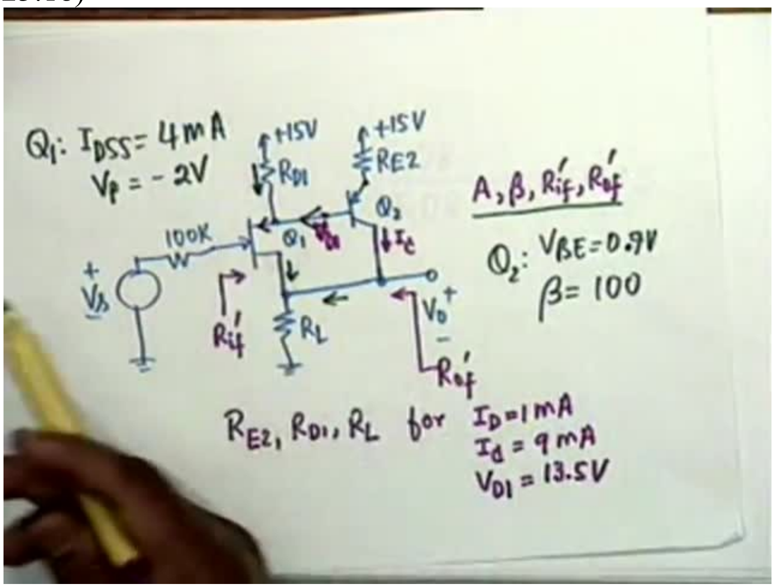

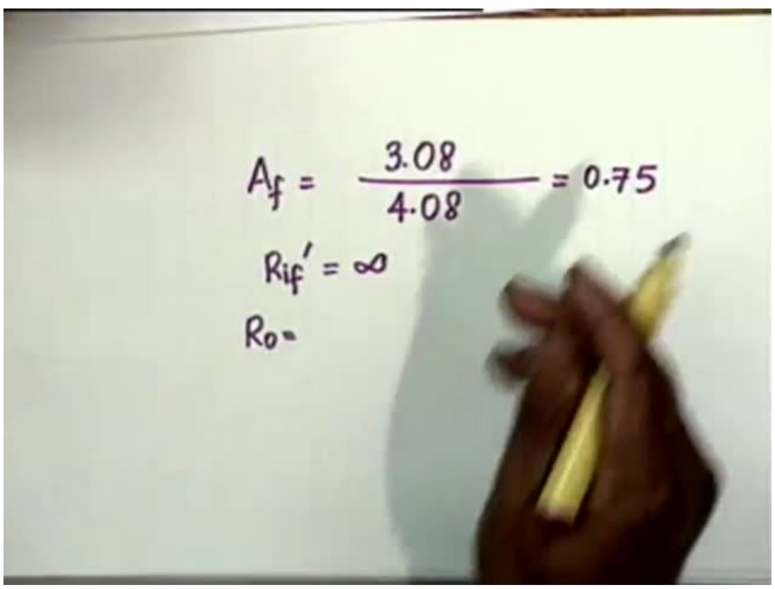

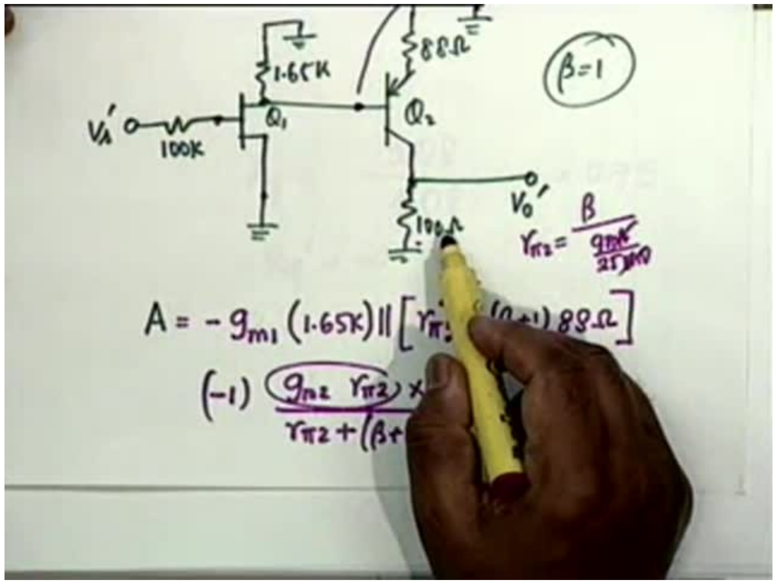

AF, the feedback gain, itis 3.08 divided by 1 +A beta, so 4.08. It is less than 1, it is 0.75. RIF prime, now if I go back to this circuit, if Idid not, I do not require any calculations to say what RIF prime would be. It is

Student:- RI.

Professor: Oh no. What is RI? What does the source see at Q1?

Student: 1 upon GM1.

Student: Infinity.

Professor: Infinity. This, the gate is opened and therefore nothing can change. Make any feedback that you like, nothing changes okay.

So RIF is RIF prime is infinity, that is no problem. My RO, that is without feedback, now look at the look at this circuit,A circuit look at the A circuit, what is RO? RO is 100 ohms and therefore this shall change.

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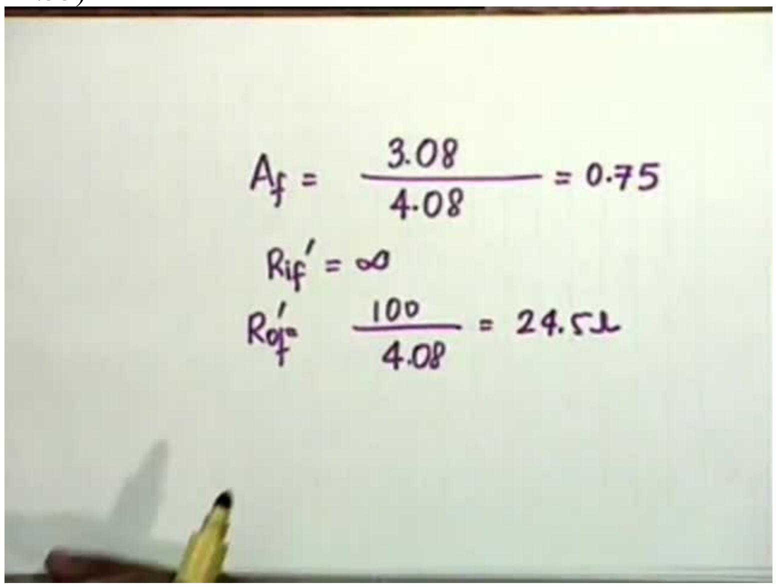

Now ROF prime would be 100 ohm divided by how much? 4.08. 1 +A beta we have already found out and therefore this becomes 24.5 ohm and that completes the example okay? You have to proceed carefully. Now in the next few examples I willnot go into the details of the numerical calculations. I will show where the trick is and how to break it. Any question on this? The next example is also a very interesting example.

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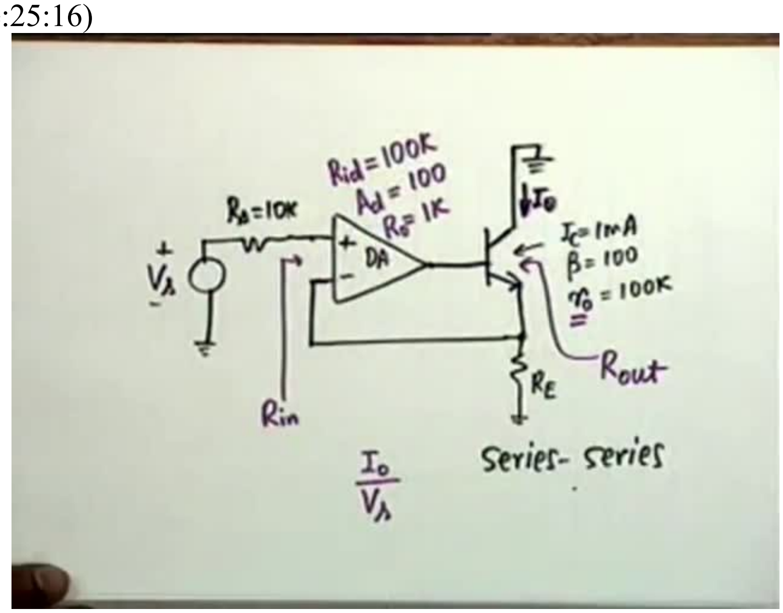

A simple circuit but you lookat the complications thatit creates. We have a VS in series with an RS which is given as 10 K, then this goes to a differential amplifier. This is a DA, not an opamp.Differential amplifier in which the negative, the inverting terminal is connected to a resistance R sub E to ground and the output goes to a BJT. Output goes to a BJT, the emitter of which is connected here, that is why this resistance is RE. Please follow carefully. I am not showing the biasing circuit. The collector is virtually grounded and this is the current that we are interested in.

This is my output. I0 okay? We have to find out. Okay what we have to find outwill be shown later but it is given that this transistor is biased atI sub C equal to 1 milliampere and for this transistor, beta is 100, small R0 okay for a change this is given to be 100 K. We will see how to take care of this. And the differential amplifier has the following specifications. Its RID is given as 100 K. The differential amplifier has a differential input resistance, that is between these 2 terminals as 100 K. RICM is not given. So we safely assume it to be unit infinity.

The differential gain is given as 100, a C is not given. So you assume that to be 0 okay. We assume CMRR to be infinity and the output resistance capital R0 is given as 1K. Do not confuse this with the output resistance. Since I have already used small r0, I haveno other option. I used a capital R0 is 1K. Is that clear? The model is floating in front of your eyes. There are 2 terminals. In between them, there is a resistance, RID. The voltage is V1 let us say. Then the output voltage is 100 times V1 in series with a 1K resistance.

That is the model. Nothing else is given, so we do not take care of anything else. So I must change my terminology now. What we have to find out is R, we can call this R out. I would not use the symbol capital R0 output resistance. Then we have to find the input resistance, that is looking from here, R in, obviously this will not be RID anymore because there is feedback okay. These are the things to be found out. Oh, I also have to find out I0 by VS.

Student: Sir, where will you take the output from?

Professor: Output is this. The current I0 is my output. This is actually a circuit of avoltage to current converter. Can you identify what the feedback connection is?

Student: Series.

Professor: series and?

Student: series-series.

Professor: series-series. Wonderful. This is a series-series which means that it is a voltage to current converter and therefore I do not have to change this. My output shall be a current. The 1st question that it asks is the following.

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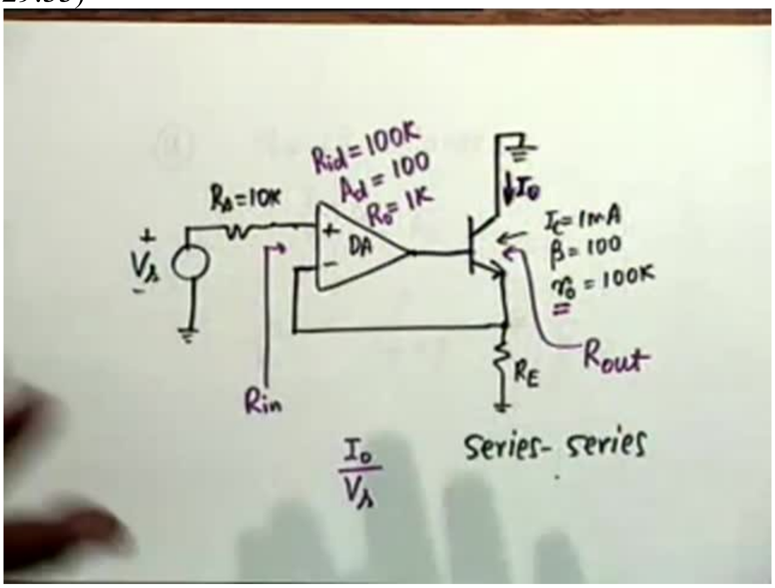

Without going into any numerical values, it says, show that if A beta is large then I0 by VS is approximately equal to 1 over RE. This is the 1st part of the question, part A.Show that if A beta is large then I0 by VS is approximately equal to 1 over RE. Now we know, this solution is extremely easy.I0 by VS would be A divided by 1 + A beta. If A beta is large compared to 1, then obviously this is equal to or approximately equal to 1 by beta. Now what is beta? Beta is simply RE. Why RE? Not 1 by RE. Because the voltage fed back, VF prime is equal to I0 prime multiplied by RE and therefore, VF prime divided by I0 prime is equal to RE. Is it obvious or I should draw the diagram?

Student: Obvious.

Professor: It is obvious. And therefore this is equal to 1 over RE.

This is the 1st part of the question without looking at anything else.

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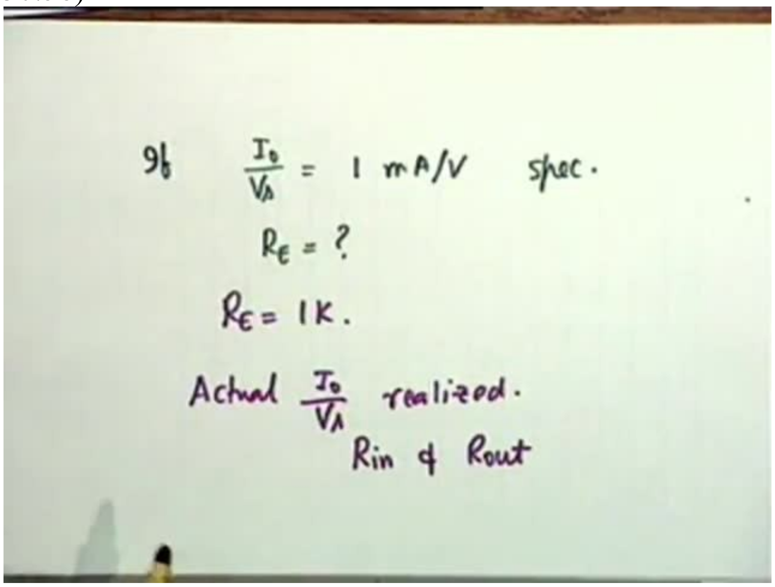

The 2nd part of the question saysthat if I0 by VS is specified as 1 milliampere per voltfind RE. Obviously, RE would be equal to

Student: 1.

Student: 1K.

Professor: 1K all right.This solution is also very easy.

Now comes the actual problem. RE equal to 1K. Now it says, make a feedback analysis and find the actual transconductancerealised because this is under the condition that A beta is large. So you now analyse the circuit to find out what is the actual I0 by VS that is realised andalso find out Rin and Rout. This is the total problem. Now let us look at theproblem. This is also a very simple problem provided you a view it as simple provided you look at it carefully.

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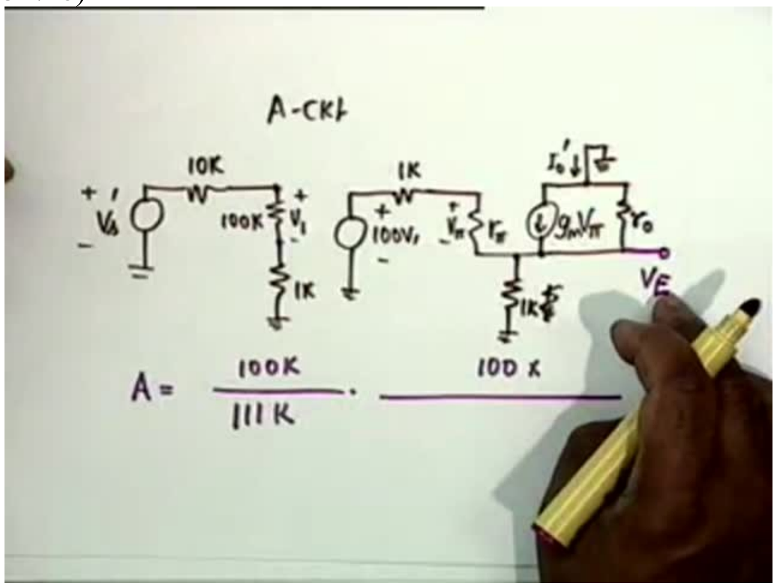

Now if you look at the circuit, I can draw the A circuit quite easily. The A circuit would be VS prime. Now comes the question of the model. VS prime, my source resistance is 10 K. Did I say this 10 K or 100 K?

Student: 10 K.

Professor: 10K all right.

Then comes the 2 terminals of the differential amplifier between which there is a resistance of 100 K, that is RID is given as 100 K. Then we have a1K. Now what do I do to this feedback circuit? This is a series-series. So I shall have to open the output which means that 1K shall come here. Agreed? Series-series. And this voltage is V1.

Student: Sir, which 1 K?

Professor: Which 1 K? It is R sub E.

Student:Sir, that would be considered as an assumption?

Professor: What assumption?

Student: If it is (())(33:19)

Professor: okay. We have used an RE equal to 1 K now okay, on the basis of approximation. Then the question is with RE equal to 1K what is the actualI0 by VS realised? Okay. Now toget the A circuit, obviously what you have to do is open here, so I get RE and as far as this transistor is concerned what shall it see? It will also see RE. Why? Because it is a series-series. Okay fine. So we go to the model, the differential gain is given as 100. So 100 V1. Too many 100s and 10s. Do not confuse. 100V1, then it has an output resistance, the differential amplifier has an output resistance of 1K.

So 1K goes here. Then comes the model. Shall we draw the model or shall we do it by inspection? We want the model. Okay. Then comes an R pi and this voltage is V pi, this is GM V pi okay. This resistance is 1K, this is that RE and in addition, you have the resistance small r0, this is grounded, the collector is grounded and where is the output now? It is the current flowing through. Is that correct?

Student: No Sir.

Professor: No.

Student: Sir, it is coming from the ground.

Professor: From the ground. So it is this current, I0 prime. Very good. Very good identification. Once you have done that, now you can write down the gain by inspection. It is a long circuit but it does not matter. You see, 1st you have to find out V1 in terms of VS prime. So the gain I can write this by inspection, the gain would be 100 K divided by 10 K, 100 K and 1K, so 111 K. 111 K, this is for the 1st stage. For the 2nd stage you have to find out I0 prime by V1. So 1st thing is you write 100 because there is a 100 V1. All right? Then you have to find out GM. Well we willsee how find that out. Will you require GM or you do not require because I0 prime is the current that is needed. Suppose suppose we find out VE, this voltage, suppose we find out VE, is not it the same current flowing through 1K? No, it is not.

Student: Sir, we need GM.

Professor: pardon me?

Student: Sir, we shall need GM.

Professor: We shall need GM, that is correct.

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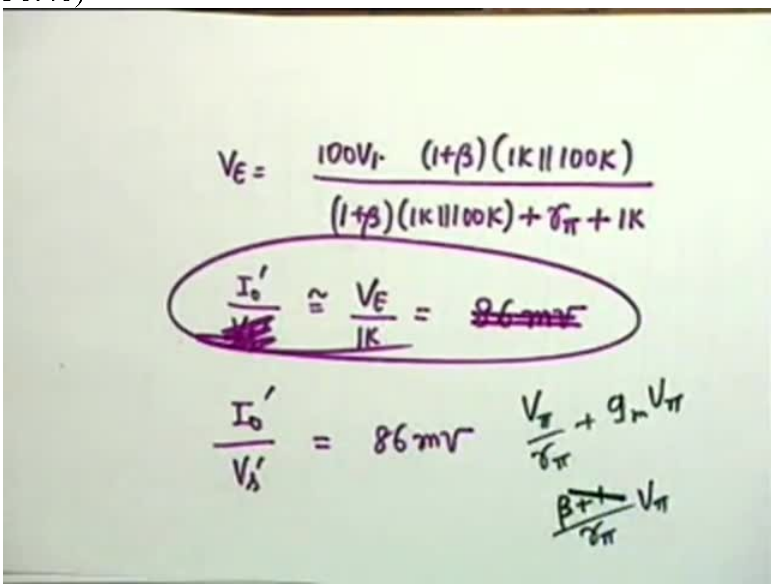

But you see that VE if you look at this circuit if you look at this circuit, VE is equal to 100 V1. Well, what is the this resistance appears as effectively 1K just a minute VE is 1K parallel R0 and the current that flows through is beta + 1 per whatever current flows here, agreed? So I can write down by inspection VE as 100 V1, then 1 + beta times 1K parallel 100 K. This is the drop across 1K parallel 100 K. Divided by 1 + beta 1K parallel 100 K + R pi + 1K. Right? This is VE.

Student: Sir please explain the numerator.

Professor: The numerator. The numerator is, VE is this voltage. How is this voltage created?1K parallel 100 K.

Student: R0 is 100.

Professor: That is right. R0 is 100 K. Given. So I know VE. Therefore I0 prime by VS prime would be equal to, if this is I0 prime, how does this current differ from I0 prime?

Student: (())(38:27)

Professor: This current is also I0 prime but we have the base current here okay. So beta, that is why that beta + 1 comes. And since 1 can be ignored compared to beta, this is approximately the same as VE by 1K which is 86 millimhos, my calculation. All right? And what was beta? What was beta? Have not we already found out what beta is?

Student: RE.

Student: RE.

Professor: Beta is RE. So beta is 1K.

Student: How VE by 1K.

Professor: How VE by1 K.

Student: Sir, dimensionally (())(39:13)

Professor: yes. Oh. I am sorry. This is I0 prime. I beg your pardon. So I have made a mistake. Okay, I0 prime is VE by 1K and VE is given by this and V1 was found out in terms of VS prime. And therefore we have to combine all these 3 questions and my final equation becomes I0 by VS prime. This becomes equal to 86millimho. The previous equation was not correct. This is theequation for the current. Thank you for pointing this out.

Student:(())(40:11) V prime by I prime? Sir, we are neglecting that?

Professor: we are neglecting that. You see, that contributes to beta + 1 and we are ignoring 1 with respect to beta. Does this require an explanation? Has the rest of the class understood? No? You see, my current is V pi by R pi + GM V pi. We are ignoring the shunting effect of R0 okay? And this is beta + 1 divided by R Pi into V pi and we are ignoring 1 with respect to beta and therefore it simply becomes GM V pi. Is that clear? This we have done again and again. But still.

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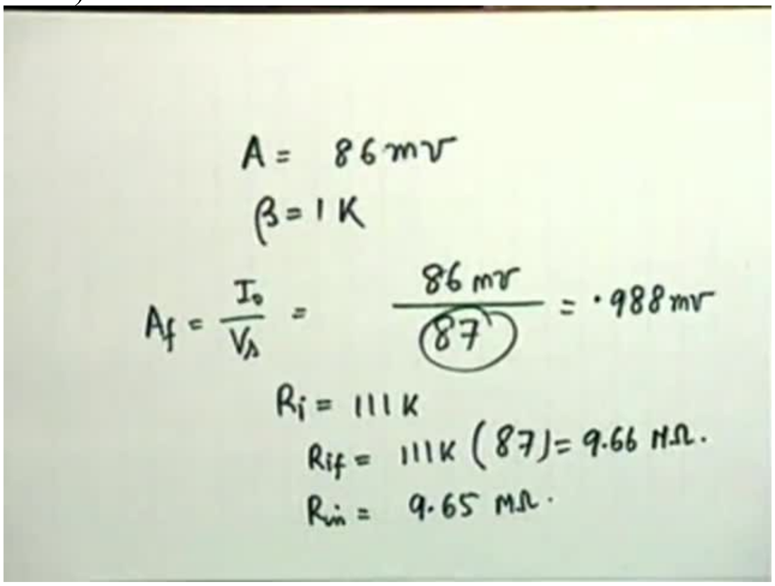

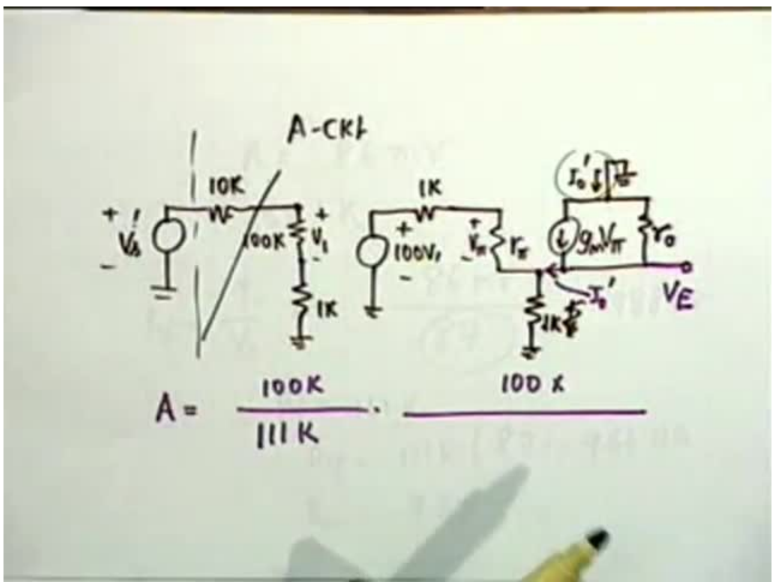

Okayso finally what we have is capital A is equal to 86millimho, beta is equal to 1 and therefore I0 by VS which is AF is given by 86 divided by, beta equal to 1.

Student: in terms of RE.

Student: RE

Professor: 1K.

Student: Beta in terms of RE.

Professor: Right, so it is 1K, not 1. You must not forget the dimension because A beta must be dimensionless.Millimho multiplied by K obviously is dimensionless. So this would be 86 by 87 which is 0.988, what is the unit?

Student:millimho.

Professor:millimho. This is 86 millimho divided by 1 + 86. So it becomes 0.988 millimho and obviously RI if you look at the circuit again, what is RI? Differential amplifier, 100 K, 10 K and 1 K. So it is 111 K and RIF therefore would be 111 K multiplied by how much?

Student: 1 by (())(42:18)

Professor: increase or decrease?

Student: increase.

Professor: Increase. It is a series-series. And therefore it will be multiplied by?

Student: 87.

Professor: 87. I have already found this factor out and this comes as 9.66 meg but this is not the impedance faced by the source. What is the impedance faced by the source,Rin?

Student:- 10K.

Student:- 10K.

Professor:- 10 K which makes it 9.65 meg.

Student: Sir, should not RI be 101 K? Sir because RS was 10k.

Professor: okay. I am glad you raised the question. Nobody raised the question earlier. This is the confusion that I want you to avoid. I have warned you before that your A circuit is now this, between VS prime and I0 prime. So it is included .

You see, if this was a current source and you have to combine this, here of course it is obvious that 10k has to be subtracted. It may not have been obvious. If thiswas a current source and 10k was absorbed in the circuit, you have to absorb it becauseone of the fundamental steps is the A circuit must absorb RS and RL. And therefore, it is not 101K, it is 111 K. okay. And the rest of the circuit, rest of the analysis, you can do yourself. R0, R out is not trivial. R out calculation is not trivial. R out calculation, you have to apply a voltage source and find the current.

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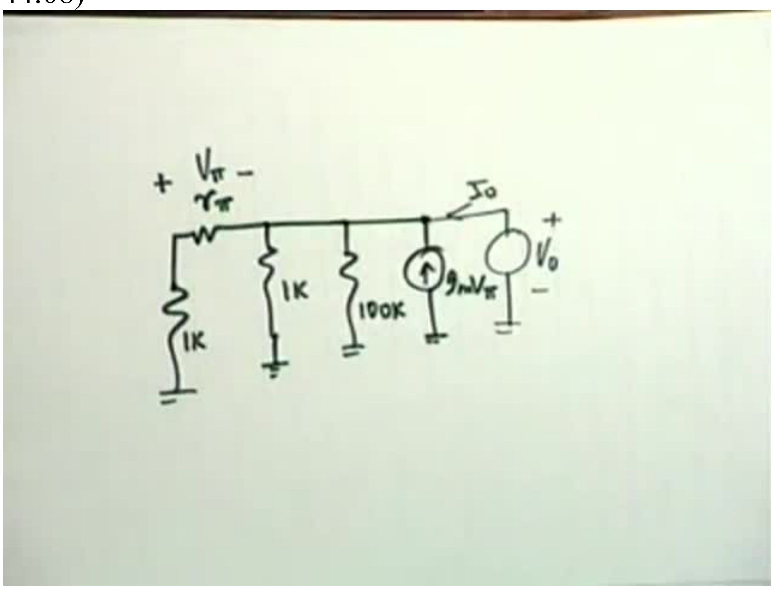

And a circuit, let me draw the circuit. You have to connect a voltage source and find the current. The equivalent circuit is, there is a GM V pi. Then there is a 100 K. What is this 100 K due to?

Student: R0.

Professor: r0, small r0. Then you have a 1K. What is this 1K?

Student: RE.

Professor: RE. And then you have R pi and then 1 K going to ground. VS has to be made equal to 0 and V pi, do not confuse the polarity. Polarity is + to the right or + to the left?

Student: To the left.

Professor: left.+to the left and -.

Student: excuse me, sir.

Professor: yes.

Student: how is RE coming parallel with GM and R0?

Professor: Oh, you look at the circuit. You look at the circuit. This is coming in parallel to R0 because this is grounded.

Student: Sir? Sir, if our output is the collector current, sothe input V not should also be given to the collector.

Professor: Input V not. That is what we have done.

Student: Sir, we have given it to the emitter. The 1st one is to the emitter, it should be to the collector.

Professor: You see, between the collector and ground, just 2 minutes. My output impedance is between the collector and emitter. You see. This is what I wanted. Collector and emitter. Now that means between emitter and, collector is grounded. So emitter and ground. That's what I have found here. Is the point clear? Okay. Now the next problem oh youcalculate this out. The next problem I will simply indicate and then ask you to work it out. I will take the most complicated one. I have 4 problems but let me take the most complicated one. Just draw the circuit with me.

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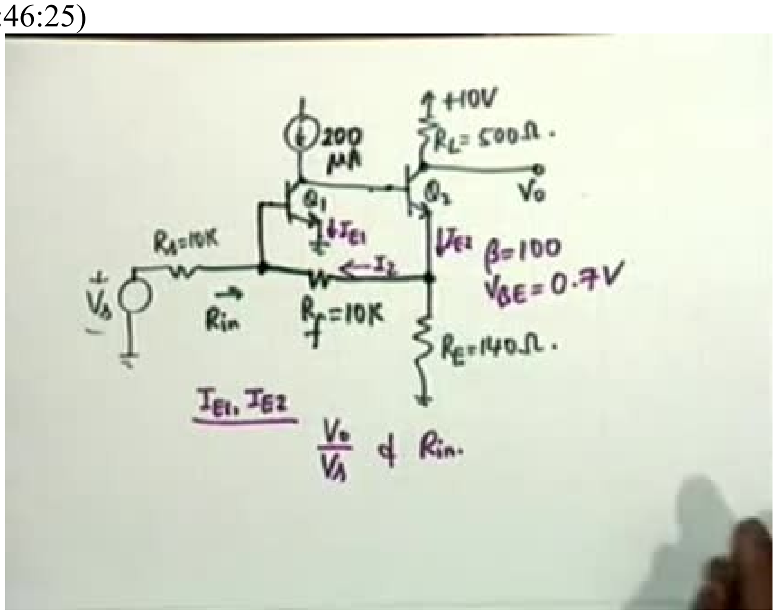

VS, RS given as 10k, you have to find out Rin.This goes to a transistor Q1 whose emitter is grounded and which is biased by a constant current source, 200 micro ampere. Very practical circuit. It forms part of a chip. There is a 2^{nd} transistor Q2 which goes to resistance RE equal to 140 ohms and between this point and RE, there is a feedback resistance RF which is equal to 10k. The transistor Q2 is biased by a 10 volt source through an RL which is 500 ohms. The output is taken here, V0.

The problem is , alright, you require some data. Beta is equal to 100 for both the transistors. What else do you need? And VBE, you can assume the VBE to be 0.7 for both the transistors, 0.7 volt. What you have to find out is IE1 DC, IE2, again DC value. Find outIE1,IE2 and the nodevoltages for all the nodes. That means you have to find out this voltage, this voltage, this voltage and this voltage. How much is this voltage?

Student: 0.

Professor: 0.7 volt. This is grounded. From base to emitter, it is 0.7. And that is the starting point of the solution. This is 0.7 and therefore you can find this current and therefore, you can sum up this current and this current and so on. But let me state the problem 1^{st}. Find V0 by VS and Rin. Okay? The major effort for this problem is in finding the 2 currents, IE1 and IE2. Let metell you how to do this. This current, you ignore the base current. No, you cannot ignore the base currents now because this current, this base current would be comparable to 200 microampere.

You cannot ignore. So what you do is, this currentIE2 is obviouslyIC1 + IC1 by beta okay. You do notignore it now because this will have to compare with 200, this is a constant current biasing okay? There is a temptation to ignore this. Then that current - the current that goes through here is dropped across here. So you know this voltage. Okay. This voltage can also be written as this voltage, the drop in this + 0.7. K? So ultimately what you will get is if this current is I2, I2, please check my solution.

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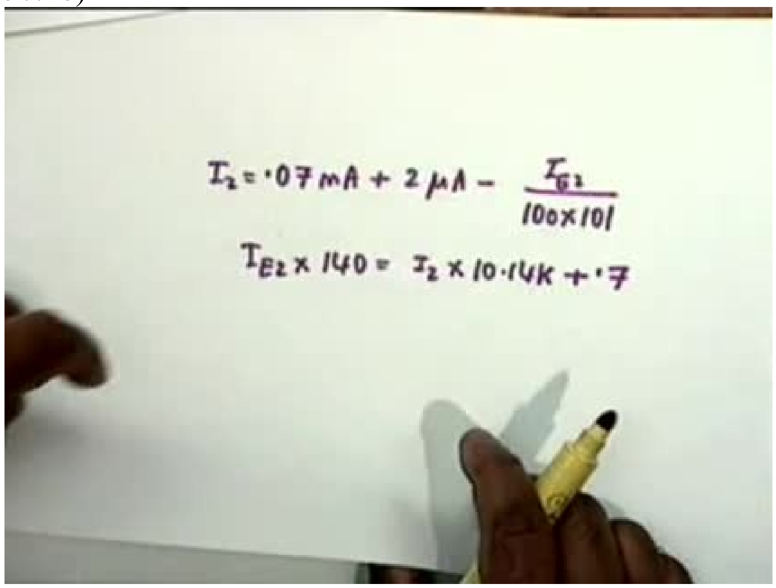

You get the following 2 equations, I2 equal to 0.07 milliampere+ 2 microampere - IE2 divided by 100 into 101. I did not ignore that beta + 1. I did not ignore here. Yes. This is one of the equations and the other equation is IE2 multiplied by 140 equal to I2 multiplied by 10.14 K. This is 200 microampere divided by 100.

Student:(())(51:23)

Professor: pardon me?

Student: (())(51:24).

Professor: No, this comes after the manipulation. You have to write the KVLs, 2 KVLs and then this is what comes, from which you can find out IE2 and therefore you can find all other currents.

Student: Sir (())(51:42).

Professor:This is my solution, it may be correct, it may not be correct okay. I may have intentionally made a mistake. Do not trust me. These are my equations. I did not go further. But tell me what is the architecture?

Student: Shunt-series.

Student: Shunt-series.

Student: Shunt-series.

Professor: Are you sure?

Student: yes sir.

Professor: okay. Shunt-series. Now what is beta? What is the beta network? What is the beta network?

Student: R2 parallel RL.

Professor: Not parallel.

Student: RE parallel RF.

Professor: Yes, that is right. RE parallel RF. And beta would be found out as the current rising through RF divided by the voltage across RE. Is that clear? Okay.

Therefore beta would be simply - 1 by RF. With a little practice, you need not draw the beta circuit at all. And the rest of the solution (())(52:46).

Student: Sir, in the solution sir, for I2 you said it is 0.07 microampere + 200 microampere.

Professor: yes.

Student: Sir, you assumed that 200 microampere is straightaway going through the…

Professor: Partly going through the base of the 2 and partly going through the collector and you can show that they are some approximately equal. That is my solution. Okay.