**Electronics for Analog Signal Processing - I**
**Prof. K. Radhakrishna Rao**
**Department of Electrical Engineering**
**Indian Institute of Technology – Madras**

**Lecture – 22**
**Transistor Biosing**

In the last class, we have understood about the characteristics of the transistor. Let us see an example as to how we can bias the transistor in the active region.

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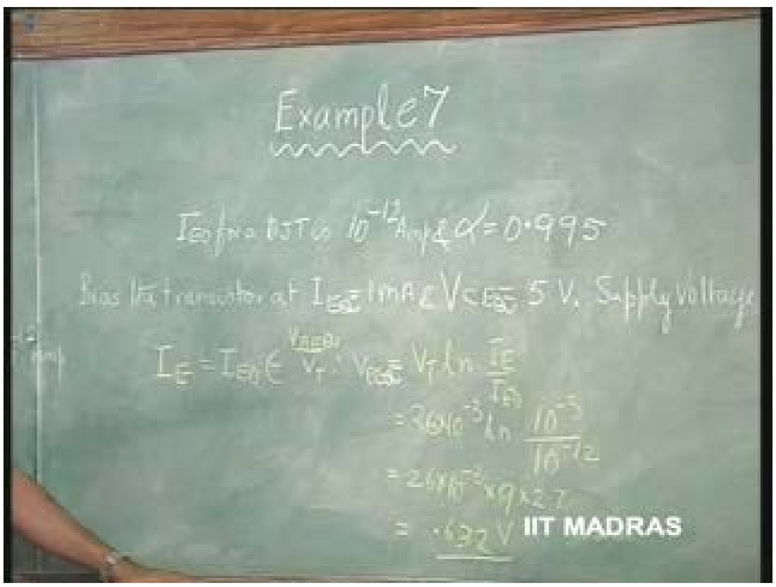


I E naught for the BJT that we have chosen is 10 to power minus 12 amperes and Alpha is point 995. This is the characteristic that is given by the manufacturer, let us say. Bias the transistor at an I Q, I E Q of 1 milliampere and V C E Q of 5 volts. So, the operating current is given and the reverse bias voltage that we have to apply also is given. Supply voltage is 10 volts. So, let us look at the circuit. Supply voltage is 10 volts. Then, I put an R C so as to adjust the collector voltage to 5 volts with respect to emitter.

So here, the collector current will be flowing, I C Q; and therefore, this voltage, V naught Q is supposed to be 5 volts. This is 10 volts minus I C Q times R C; and I C Q is already known to be Alpha times I E Q. Alpha is point 995. I E Q is 1 milliampere and therefore this is 10 minus point 995 milliamperes into R C.

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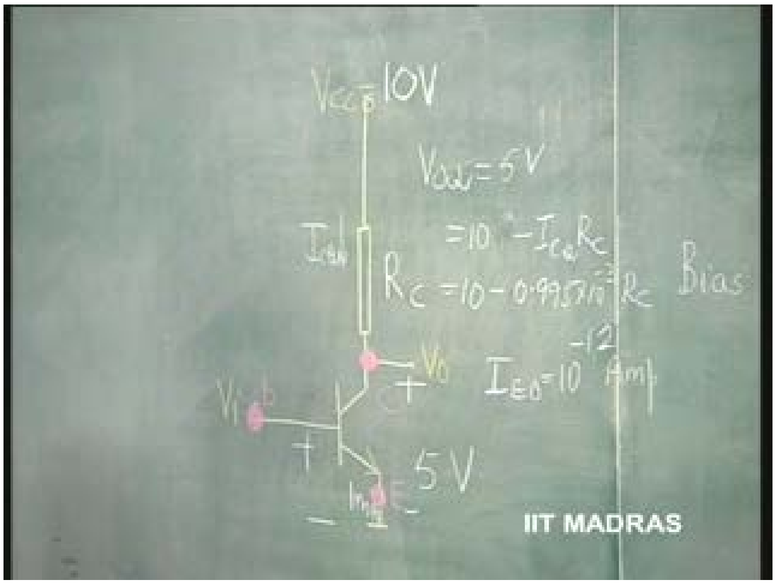


So, if this is given, then we can find out what should be the value of R C, in order that this condition is satisfied. This should be 5 volts. So, we have, from this equation, 5 equals, 10 minus 5, equal to point 995 into 10 to power minus 3 into R C; or, R C is 5 by point 995 Kilo ohms. So, this is equal to 5 point 025 K.

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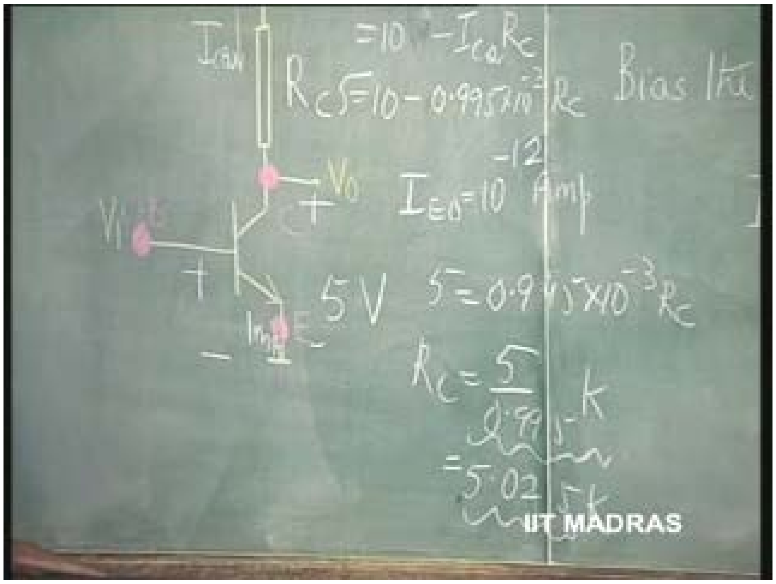


So, we have now found out the value of R C in order to make the V C E Q equal to 5 volts, for the transistor that is given. Now, we have to find out what V B E Q should be; V i Q or V B E Q. How much is this, in order that I E is to be made equal to 1 milliampere?

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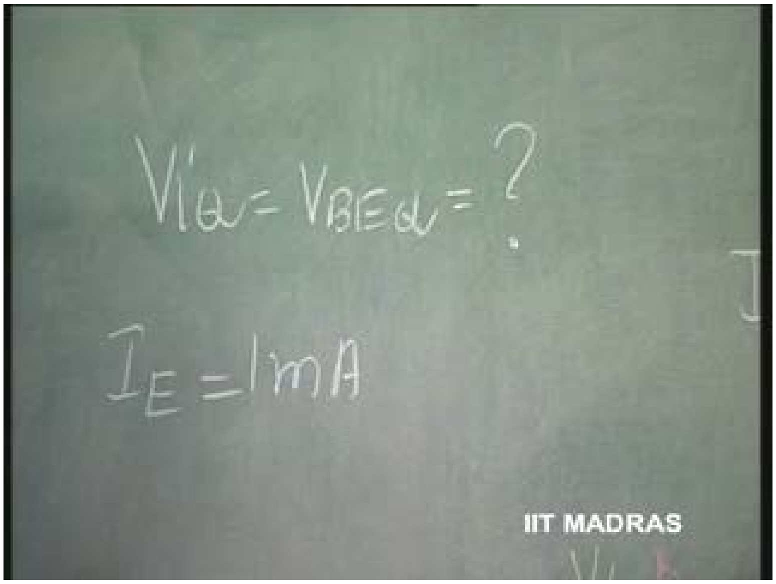

This, we can look at here, the equation. I E here is given as I E naught exponent V B E Q by V T. This is known; the diode equation. So V B E Q is V T log I E by I E naught, from this equation. So, V T is known to be 26 millivolts; 26 into 10 to power minus 3 log of 10 to power minus 3 divided by 10 to power minus 12. This is given here. I E is 1 milliampere. This is 10 to power minus 12. So, 26 ten to power minus 3; this 9 into 2 point 7. So, this is coming out as point 632 volts.

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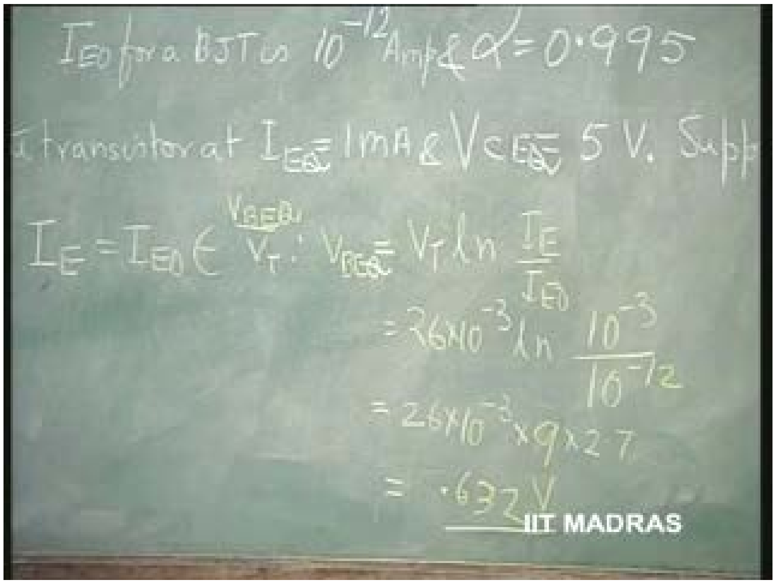


So, this voltage here has to be point 632 volts. So, this is going to be point 632 volts. As I already indicated that this is typically between point 5 and point 7 volts. So now, for a given transistor, we have found out that it is point 632 volts.

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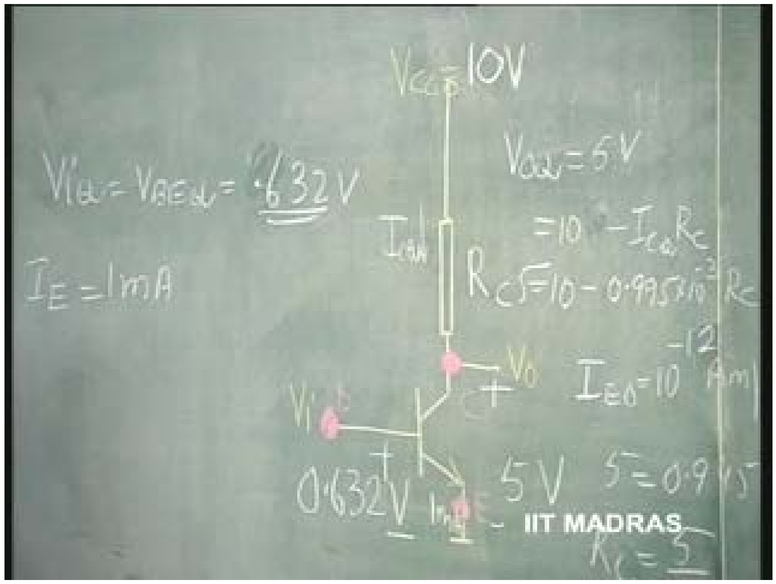


Now, how do we bias this? Obviously, I should now apply a voltage, D C voltage, which is point 632 volts. Now you can see here, this particular thing is already 10 volts D C; which means, actually there is a D C voltage 10 volts with respect to the common point and another supply which is point 632 volts.

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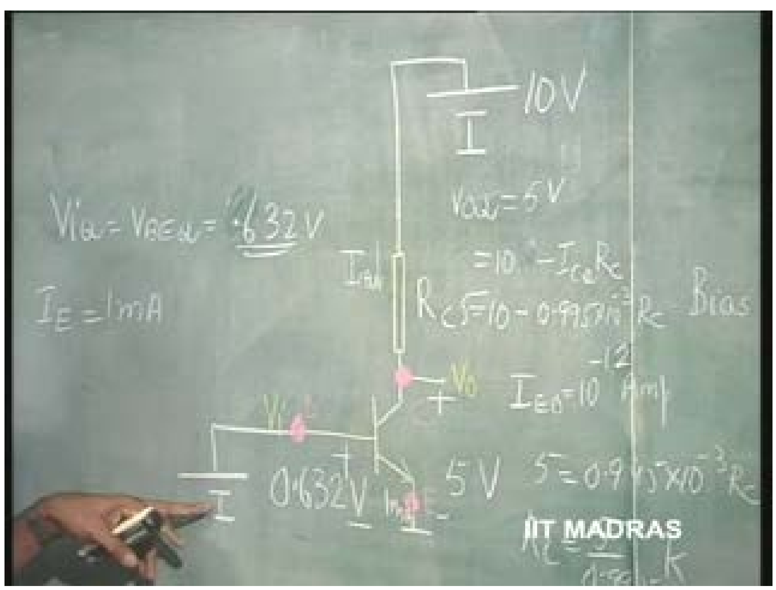

So, this is not a nice thing to happen because, we require two supply voltages; one is 10 volts, that is easily obtainable; but this point 632 volts is difficult to get. We can derive, of course, point 632 from 10 volts; but it is not going to be an ideal battery. It will be a battery in series with the resistance. So, it will be non-ideal. So, how do you really get a battery of this exact voltage?

It is very difficult. If I say the transistor is different than this voltage, may be, for 10 to power minus 13 amperes or so... so, this may be point 7, something. So, that means this is very sensitive. The current here is very sensitive to this voltage. If I am not able to make it point 632 and if it just dips to point 631, then the current is going to be drastically different from 1 milliampere. That is because, the current and this voltage, they are exponentially related; and therefore, the biasing by using a voltage like this is very unstable way of biasing a transistor, because, this voltage and this current, they are very sensitive to one another. And therefore, this voltage, small variation in this voltage, will cause a large variation in this current.

So, biasing this in a stable manner by using a voltage source here is very difficult. This is unstable way of biasing. Then, how do I really bias this? I know that I have to have 1 milliampere of current here. If Alpha is point 995, then Beta of the transistor, which is, Alpha by 1 minus Alpha, is going to be point 995 divided by 1 minus point 995. This is point 995 by point, let us say, zero zero 5; so, this is going to be equal to – how much is this? – 199.

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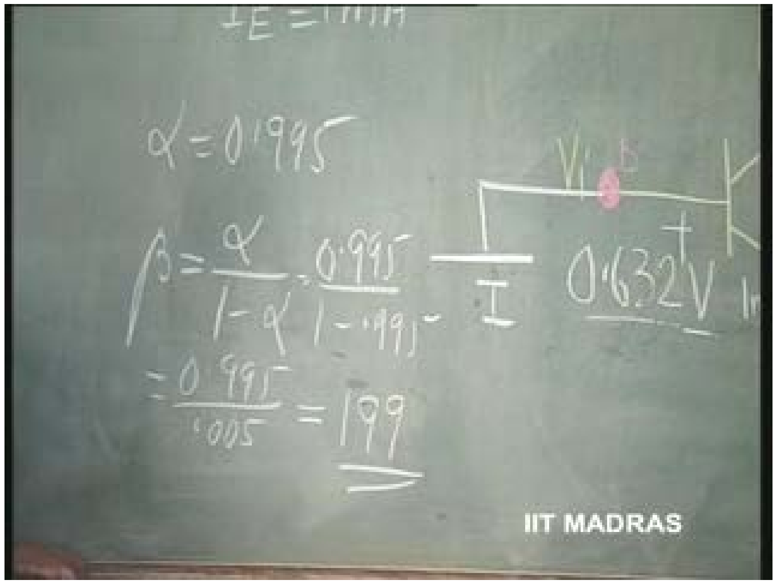


So, you can see, Beta is very high. What is Beta? Beta is the ratio of I C and I B. This is equal to Beta.

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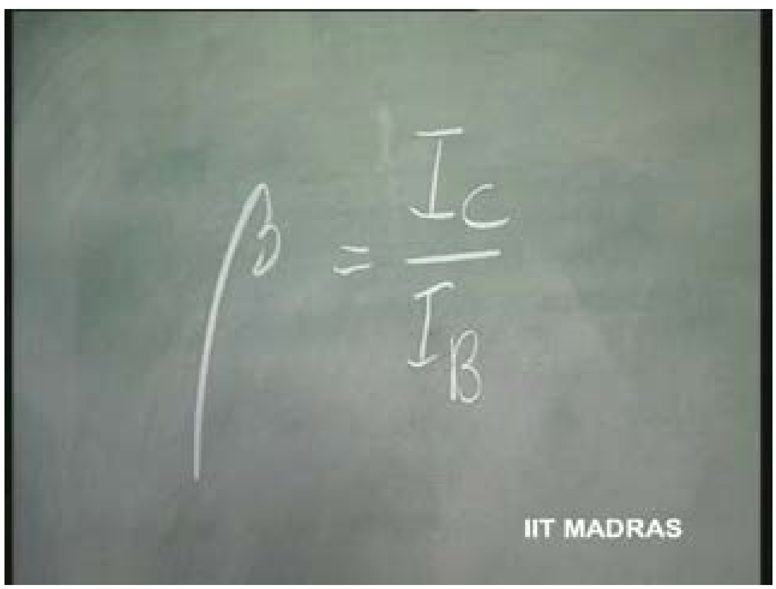

So, this is given as 199. For a current of I C Q of 1 milliampere, what is I B Q? That we can find out. 1 milliampere divided by 199. So, this is the current which is going to be of the order of microamperes. How much is this? This is going to be, this is really 200; and therefore, 1000 divided by 200, which is 5, around 5 microamperes; so approximately, about 5 microamperes.

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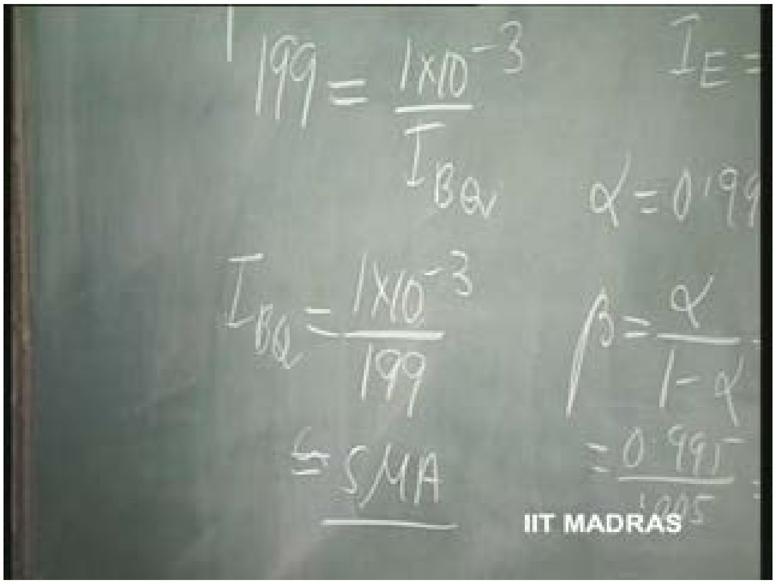


So, it is enough if I fix the current as 5 microampere for this transistor in order to make the emitter current equal to 1 milliampere, and collector current equal to point 995 milliampere, instead of bothering about this voltage. So, an alternate way of biasing this is, instead of using this point 632 volts, I know that it is point 632 volts, I will now bias this such that this point 632 volts is got by a current and that current can be how much? – about 5 micro amperes. Then automatically, this will be point 632 volts.

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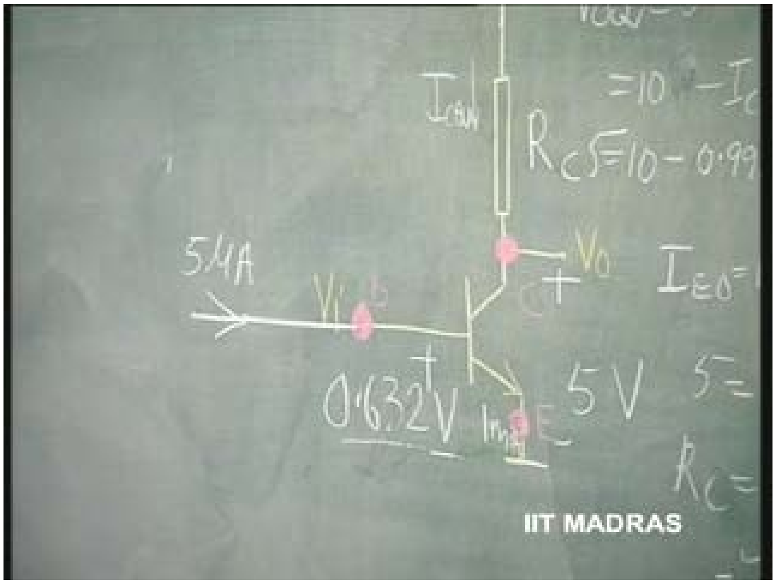


So, how do I make this 5 microamperes? I will try to use the same supply, put a resistance R B in series with it, and put the same supply, so that they can use same 10 volt supply, both for reverse biasing the transistor by 5 volts, as well as forward biasing the transistor, so that 5 micro ampere current flows; so, this is 10 volts.

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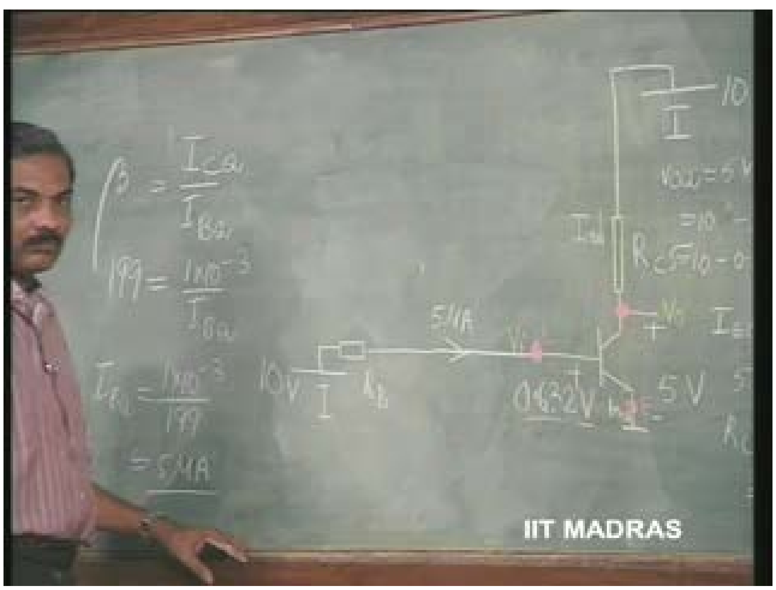

So now, the problem is, given as this is 10 volts, which is the same supply as that, I have to find out R B in order to make this current equal to 5 microamperes. That is very simple. This is 10 volts minus point 632; that is the drop across R B. That divided by R B should be equal to, this voltage minus this voltage; that divided by R B, should be equal to 5 microamperes. Or, R B is going to be equal to, this is going to be 8 6 3, 9 point 368 divided by 5 mega ohms, mega ohms; which is... how much is it? 1 point, 1 point 87 ohms.

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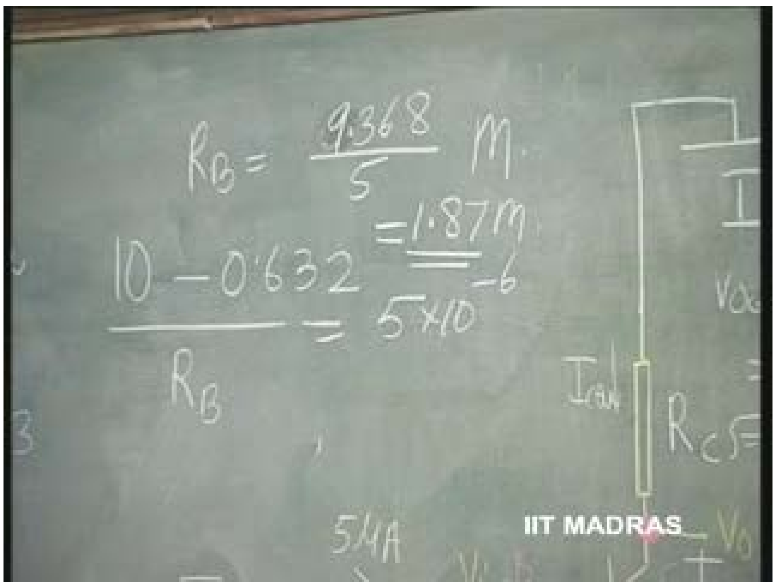


This problem therefore illustrates classically how biasing for this transistor is done in a simple manner by fixing the base current here, rather than fixing the base to emitter voltage. So, what does it mean? The circuit, if I redraw the circuit, this R B is connected between base and this positive terminal of the terminal voltage, 10 volts. So, I will redraw the circuit.

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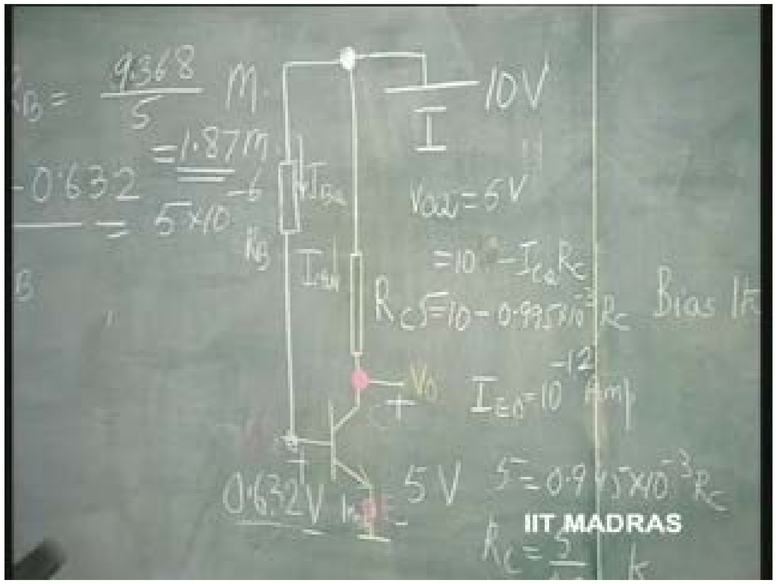


So, this is R B. So, this is a single supply biasing of the transistor in common emitter mode. It has to use two resistances: one to fix up the reverse bias voltage R C and another to fix up the forward bias current as I B. So, you can therefore bias a transistor like this by using R B and R C in common emitter mode; emitter is the common terminal between the output and the input.

But, this also is not a very stable way of biasing. What happens here is as long as this is 10 volts and this is about point 6, this current is continuing to be this 5 micro amperes. This will remain constant. That is what we have put. But, Beta for different transistors will be different. For one transistor, it may be point 995; another one, it may be point 996. That means, Beta is going to be different, for different... If it is point 99 for one transistor and point 995 for the other transistor, the Beta is going to change from 100, that is 200 to 100; very nearly.

So, that means, if for example Beta changes, because Alpha changes from very small amount, point 995 to point 99, you can see that Beta changes from 200 to 100. So, the current here, if it is fixed for a Beta of 200, then it is going to be double that; or, if it is fixed for a current of, that is 200, then it is going to be half of it, for Beta equal to 100.

Or, if it is fixed for 100, Beta equal to 100, it will double for 200. So, the current I E is going to be very sensitive to Beta variation here.

So, this kind of thing should not happen, in again, a biasing circuit. So, what should you do? This is not again that stable a way of biasing. Fixing I B Q is not good. What should we fix is I E Q itself. That can be done in the following manner.

So, I do not want to fix this current; but I can fix I E Q. I will fix the reverse bias voltage using this supply and R C. But now, I will decide to use another supply for forward biasing; independent supplies for forward... Then, that will fix the current in the emitter. This voltage is going to be, already we have fixed as point how much is it? – 632. But now, it is negative. So, if I ground this base, connect it to ground, make it, make that common, and apply a negative voltage of point 632 to emitter, then again, it is biased according to what we require.

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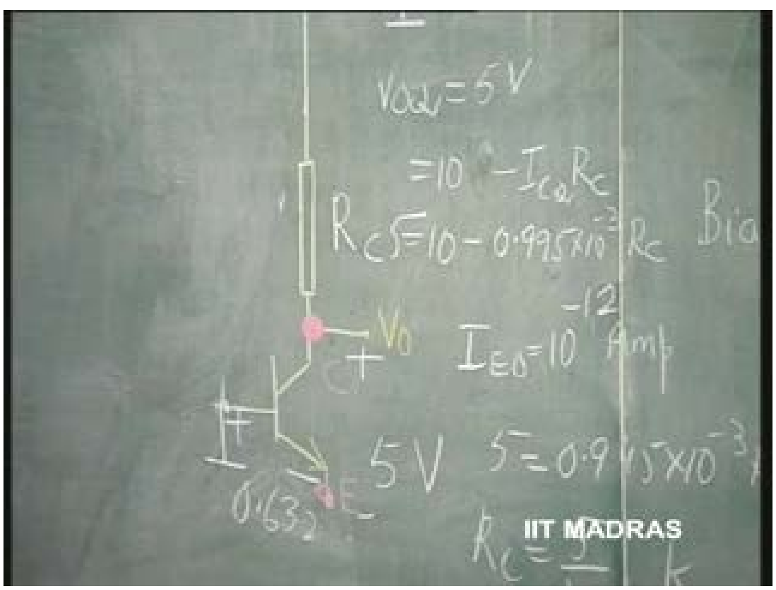


But again, getting point 632, negative voltage, is very difficult. Instead, I can get an emitter current of 1 milliampere by putting an emitter resistance R E; and let us say, we will use a supply voltage which is negative here, but equal to 10 volts. Minus 10 volts is what is going to be used with respect to ground here; and plus 10 volts here. So, this is using dual supplies.

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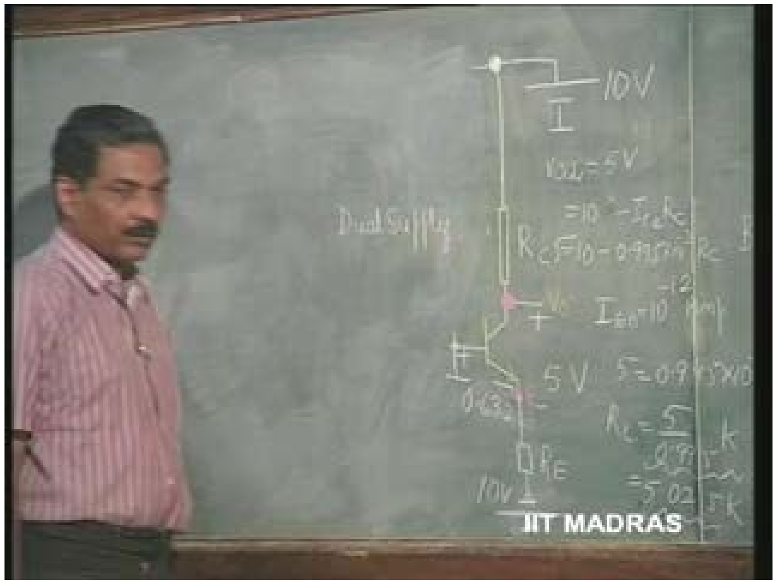


So now, you are fixing the emitter current. So, it is going to be 10 minus point 632 divided by R E. This has to be made equal to 1 milliampere. So now, this voltage minus this voltage divided by R E is the current in this. This is negative. Minus point 632, minus point 632; minus of minus, that is plus 10 volts, divided by R E. That is the current. That is equal to 1 milliampere; and therefore, now what happens? R E gets fixed as again 8 6 3 9 K; 9 point 368 K.

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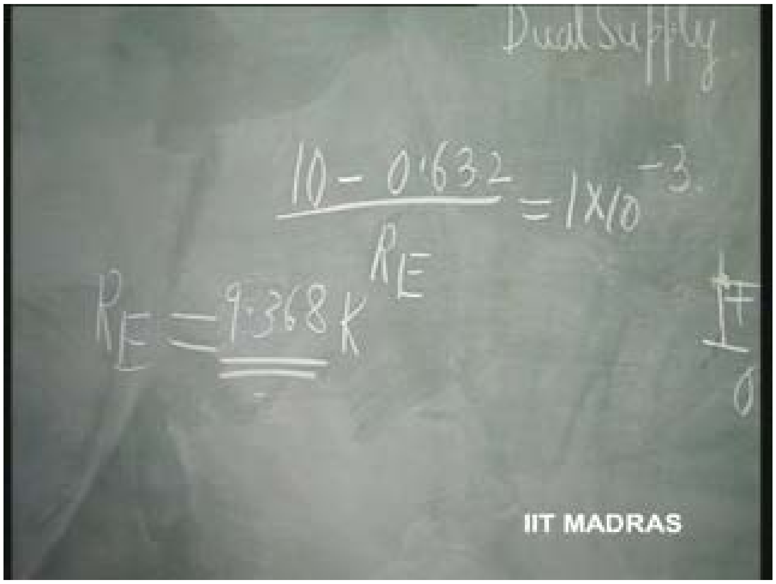


If that is fixed, then, now look at it. Irrespective of the transistor Beta, since I am fixing I E itself, the base current will have to adjust itself. As Beta changes, base current will change; that is of no consequence; emitter current remains constant. So, this is a stable way of biasing a transistor.

So, if emitter current is fixed as 1 milliampere, collector current has got to be point 995 times that; or, point 99, depending upon the Alpha. So, whether it is point 995 or point 99, it is very nearly 1 milliampere. So, it does not really matter. Even if Alpha changes or even if I use different transistors belonging to different manufacturers, the current here essentially remains constant at about 1 milliampere. So, this is a stable way of biasing.

So, we have now understood three ways of biasing a transistor in the forward direction. One - just apply a voltage of point 632, keep the emitter grounded, apply a voltage of point 632 positive to the base, which is very sensitive. That is, emitter current is very sensitive to this voltage. So, if this voltage changes even slightly, it will change drastically; and this voltage of point 632, it is difficult to obtain, exactly. So, instead, we ground this and connect a base resistance and apply it to the positive voltage 10 so that the base current gets fixed; in which case, collector current or emitter current will be dependent upon the base current, since the base current is fixed. And, base current for this problem with point 995 ohm Alpha, is equal to 5 micro amperes; and I fix the base current as 5 micro amperes by putting an appropriate base resistance and connecting it to 10 volts.

That also is not a very satisfactory way of biasing; because, if Alpha changes from point 995 to point 99, the emitter current will change to half the value. So now, R E, if we introduce with another supply voltage, this base is grounded. Now, you have to apply minus point 632 here. That is also not a good way of biasing.

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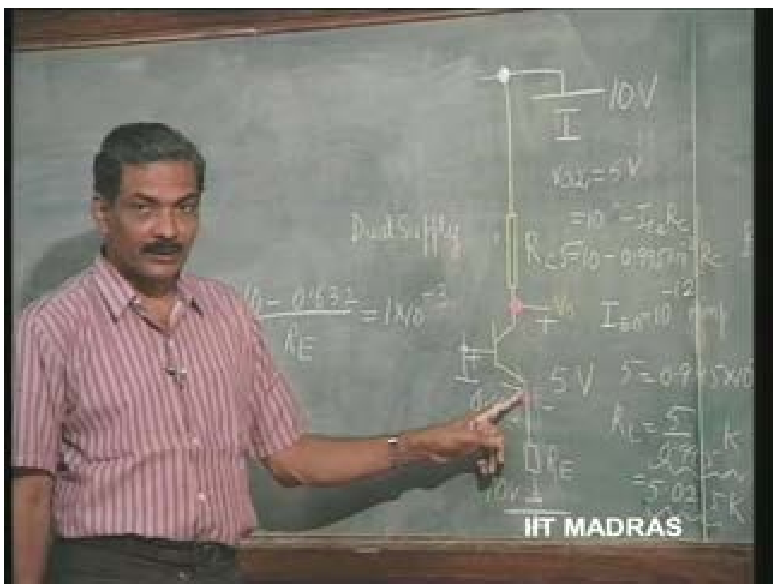


Instead, I will use minus 10 volts, whereas I have used plus 10 volts for the positive, that is dual supply; and then, put a series resistance of R E in the emitter to fix the emitter current as 1 milliampere; which is a very stable way of biasing. That is, even if the transistor is changing from this type to another type, or transistor Beta itself changes due to different temperatures, etcetera, then, the collector current essentially remains constant at 1 milliampere.

Now, let us understand the important aspect of biasing a BJT amplifier. A BJT works as an amplifier, we have already understood, if, base emitter junction is forward biased and collector base junction is reverse biased. So, let us consider a very simple arrangement where applying a single supply V C C, let us say, and in series with it R C and collector. We can make I C flow through this and bias this at V C E equal to V C C minus I C R C. So, that takes care of the reverse bias.

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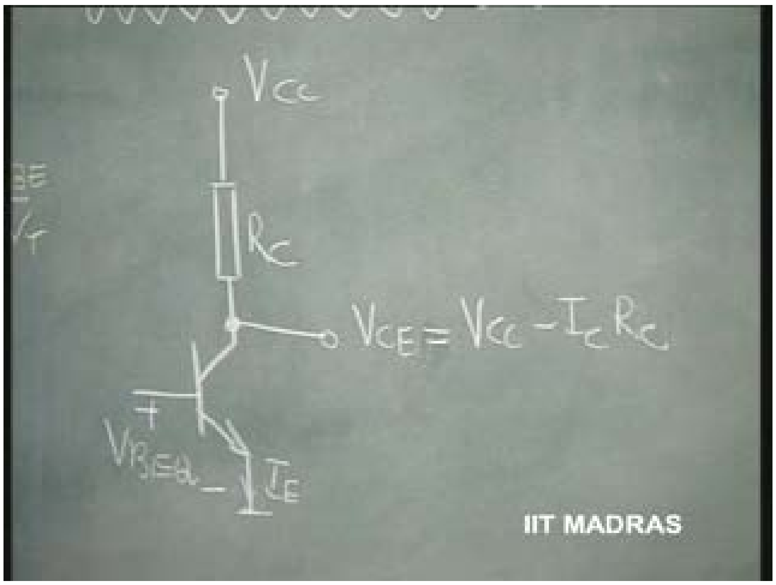


And as far as forward bias is concerned, we have to forward bias this base with respect to emitter by an extent V B E Q depending upon what current we want through the transistor; this is the emitter current. So now, emitter current and base to emitter voltage, they are related, approximately, this relationship I E is equal to I E naught exponent V B E by V T; actually, that minus 1 has been ignored.

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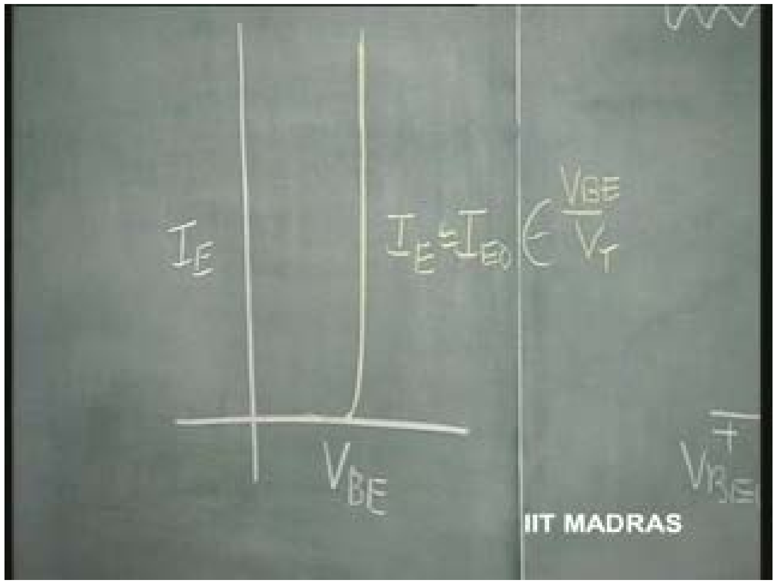


So, I E is equal to I E naught; which means, this is the characteristic. You can see that it is following a characteristic like this. Up to this, the current is essentially going to be almost zero; and thereafter, current increases enormously. This is what is interpreted by this equation. What it means is that it is very crucial; if I am fixing up V B E Q, if I want a certain I E, I want to operate at this I E Q; then, I have to exactly know what this voltage is. Even if it is slightly different, this current is going to be, may be, very low; or, if it is slightly higher than this, it may go to a very large current.

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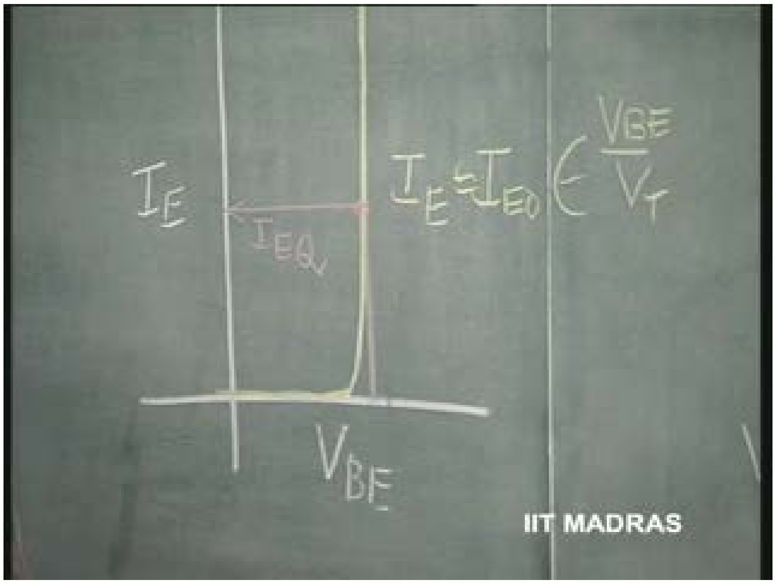


This is going to be causing problem in terms of... For example, let us say I want an I E Q of, let us say, 1 milliampere for this and V C C is 10 volts and the resistance R C is 5 K. So, 5 volts comes here. This is the example which we had just worked out. 10 volts was V C C and 1 milliampere was the current and 5 K was the resistance here, so 5 volts here.

It is exactly set in between 10 volts and zero volts. So, nicely active device has been operated at a mid-point of the 10 volts and zero volts. So, it can swing around that. But, suppose this V B E Q is slightly higher; then, let us say the current actually should have been 10 milliamperes according to that V B E Q. But then, if you had put 10 volts and 5 K, the maximum ever current in this is going to be 10 divided by 5 K, which is 2 milliampere.

That means it cannot work any current greater than 2 milliamperes; which means, if you are putting a V B E Q which is greater than that can cause a current of 2 milliamperes, the transistor will automatically go to saturation, because it cannot satisfy the transistor equation, which says, I E should be equal to Alpha times...or, I C should be equal to Alpha times I E.

This is not fine; so which means, for any voltage which is greater than that exactly specifying voltage that is here for 1 milliampere, this may be go to saturation. It will not any longer work in the active region. So, this way of biasing is no good; fixing this voltage here. So, that further purpose we said, we will put, we will make a base current flow through this corresponding to I E; if it is 1 milliampere, the I B is going to be I E divided by Beta plus 1.

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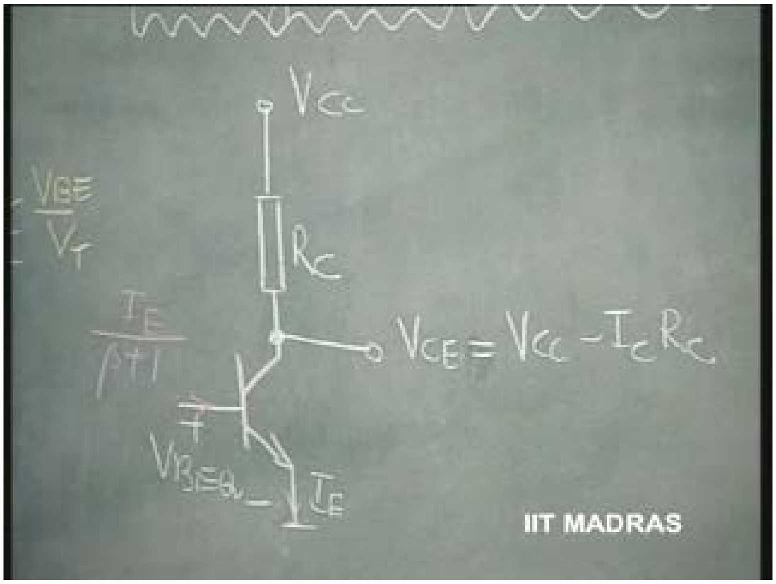


That is because, I C is equal to Beta times I B; and therefore, I E is equal to I C plus I B. Therefore, we have I E is equal to Beta times I B plus I B; or, it is equal to Beta plus 1 times I B.

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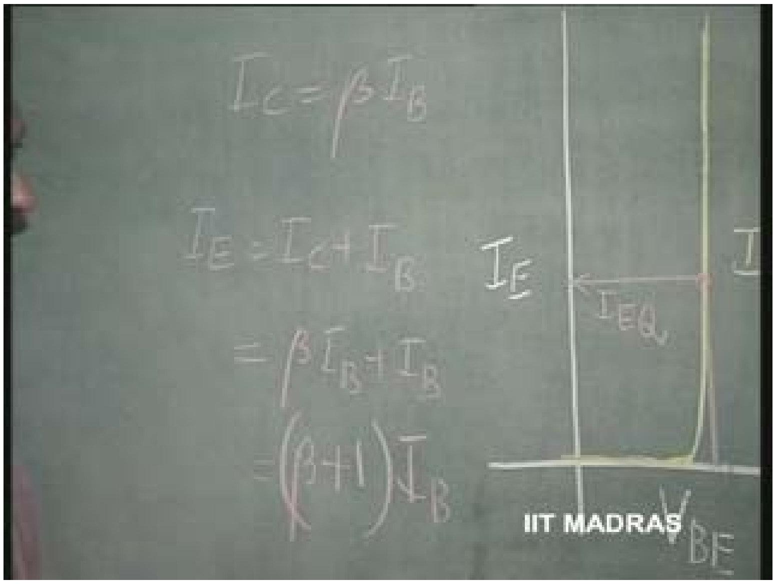


So, if I therefore fix the base current as I E divided by Beta plus 1, suppose emitter current is given as 1 milliampere and Beta is given as, let us say, 199, then, 1 milliampere by 199 plus 1, 200, which corresponds to about 5 microampere, is what I have to fix as base current. It is easier to do this than to find out what V B E Q is; and that we found out as about point 632. If it is even different from this by about 1 millivolt, current will be drastically different. So, we will fix the current of this as I E by Beta plus 1. How do I do that? I will now put another resistance which I call as R B so that this current in this is nothing but V C C minus V B E Q, which I already know for that current, divided by R B.

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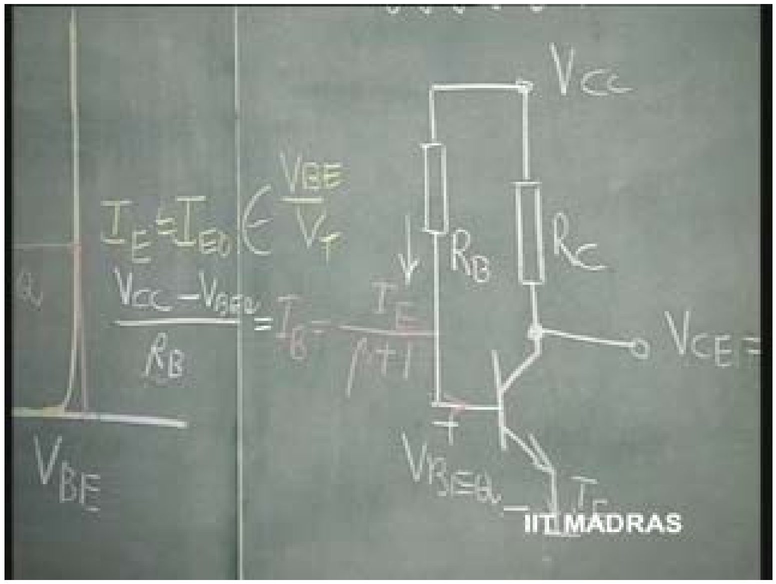


This is ... V C minus V B E Q by R B is this current. So, this is an important equation for biasing a transistor this way. So, the forward bias is fixed this way by fixing the current rather than the voltage. If I fix the current, automatically, V B E Q will adjust itself so that, that current flows as a base current. Then, if that current flows as a base current corresponding to point 995 or point 99, depending upon the Alpha, the emitter current gets fixed. So, this is the way of fixing base current.

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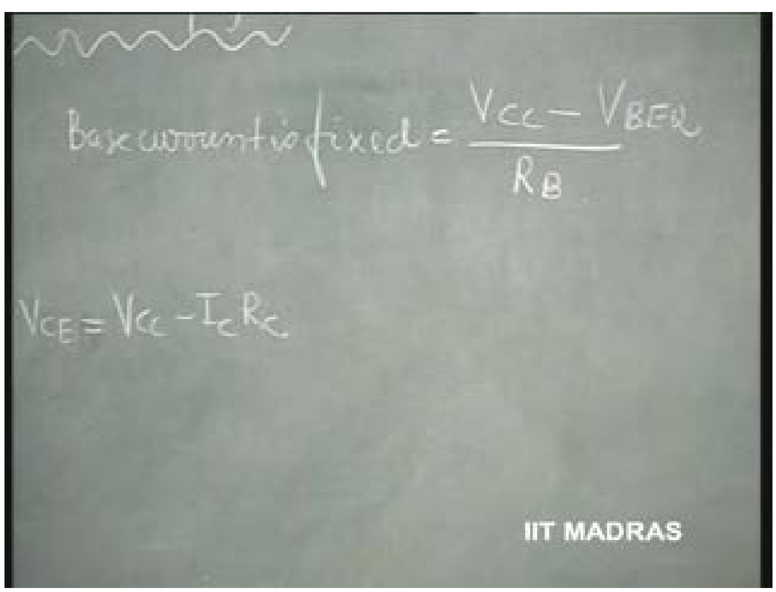

What do you mean by – base current is fixed? This is now determined by you. This is V C C minus V B E Q, which you can typically take as point 6; there will not be much of an error; divided by R B. So, that will forward bias this junction; and automatically, we have the reverse bias fixed by this V C E equal to V C C minus I C R C. This is one way of biasing a transistor in common emitter configuration; emitter is common to the input as well as the output.

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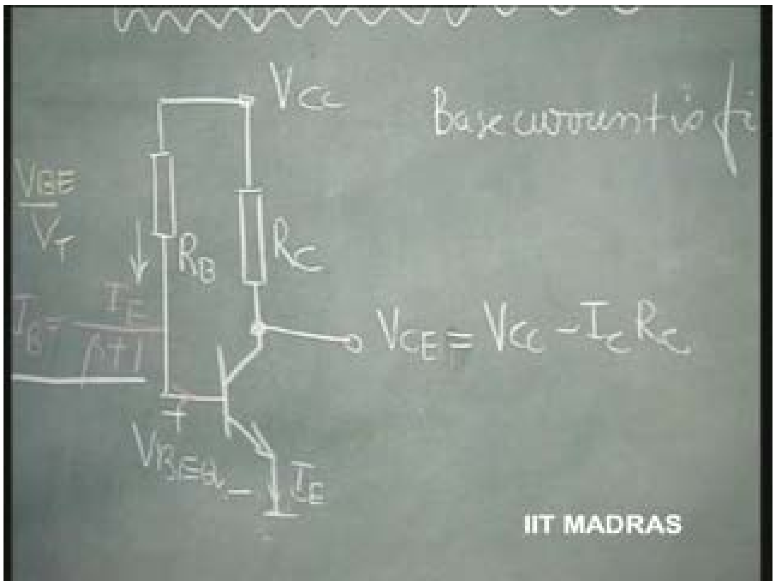


But, as I told you, if you fix the base current as this value, then the emitter current or collector current, which is what we want, is going to be Beta times V C C minus V B E Q by R B.

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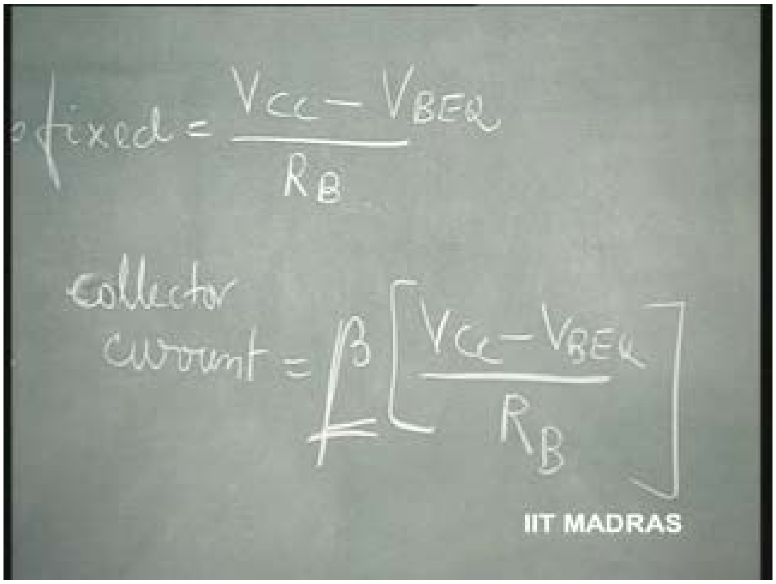


So, it is sensitive to variation in Beta. So, this is not a very good way of biasing. We have desensitized as far as I B variation is considered. I B is not very constant because V B E Q is very small compared to V C C. So, this is V C C by R B itself, approximately. But still, this is sensitive to Beta variation. So, this is not a good way of biasing, even though this is a way of biasing. Then, the alternate way of biasing, as I told you, which we have already discussed in the example is not a common emitter configuration, where base is made common.

Then we have this still coming into picture. This is V C C. This is still... this point with respect to common point is still V C C. So, V C equals V C C minus I C R C; that is still valid. That is collector voltage, not V C E; the collector voltage with respect to common point, whatever it be. And emitter voltage now has to be negative because it is V B E Q. Base is made common. With respect to base, all the D C voltages and A C voltages are measured; so base is common.

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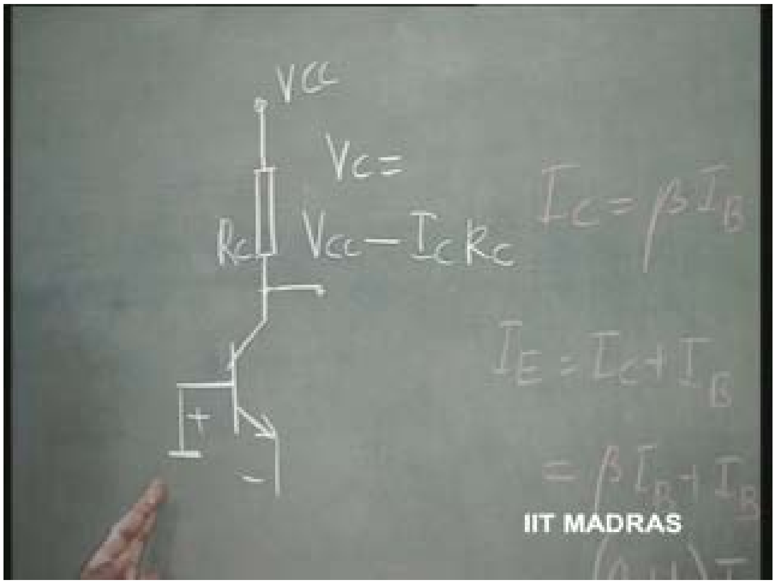


Now, I have to necessarily use a negative voltage because this is a positive voltage with respect to base. So, I have to use the negative voltage. That means I could use V B E Q which is negative, appropriately chosen, so that this current is there. But again, that is a bad way of biasing because that V B E Q may not be exactly known. So, I put a resistance here and connect it to, what we call as V E E; call this negative, minus V E E.

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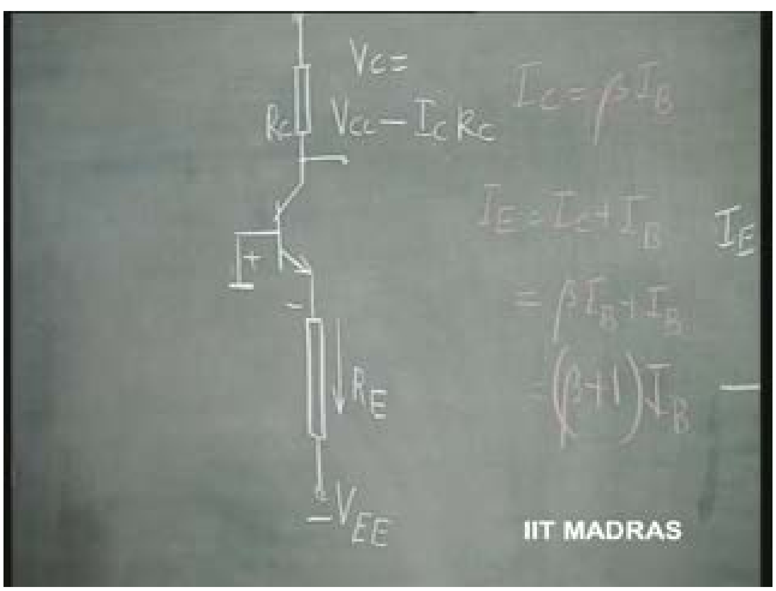

So this resistance, we will call as a resistance put in the emitter to fix the current, which is emitter current, as equal to V E E minus V B E Q divided by R E. So, we have, minus V B E Q, minus of minus V E E, that is plus V E E divided by R E. So, this is the emitter current. So here, this is the circuit in which emitter current is fixed.

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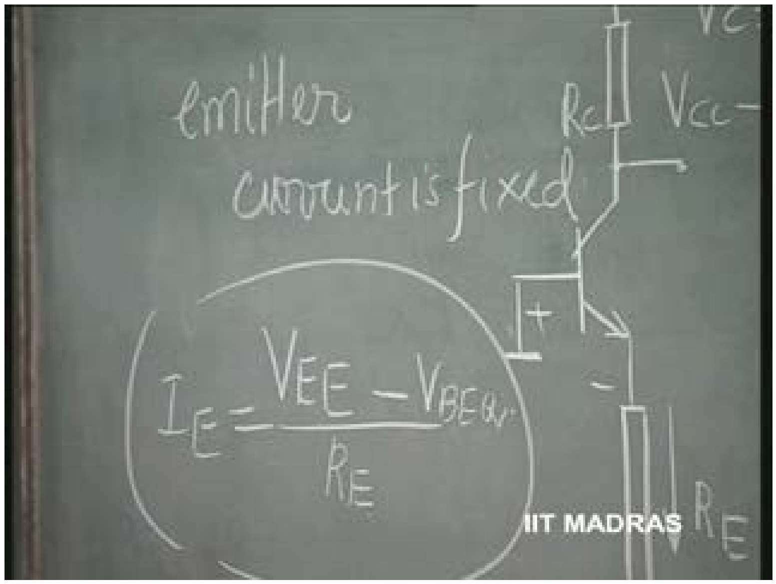


If emitter current is fixed this way, what is collector current? Collector current is going to be now Alpha times, the same expression, V E E minus V B E Q by R E.

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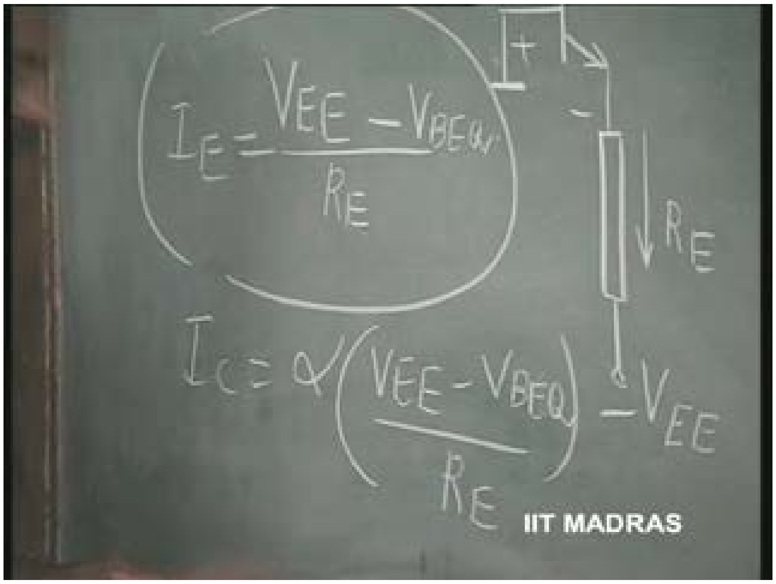


Now you compare this with the earlier one. In the earlier one, the collector current I C was Beta times V C C minus V B E Q by R B, when Beta is very sensitive to temperature and the device; whereas Alpha, even if it changes from say, point 99 to point 995, it is very close to 1. So, collector current does not change. Whereas, when Alpha changes from point 9 to, point 99 to point 995, Beta will change from 100 to 200. So, that is very sensitive whereas this is not very sensitive.

So, if you want the bias to be stable, why do you want bias to be stable? – because, whether it is this transistor with this value of Beta, or some other value of Beta, I want the operating point to be in the active region of interest to me; not go to saturation or something like that. So, if emitter current gets fixed as 1 milliampere, collector current is very nearly 1 milliampere irrespective of the transistor I use. For a supply voltage of 10 volts and R C equal to, let us say, 5 K, it is going to remain the same; the reverse bias and the collector current essentially remains the same irrespective of the transistor; whereas, that is not the case with this arrangement of biasing where the base current is fixed.

So, this is a bad way of biasing.

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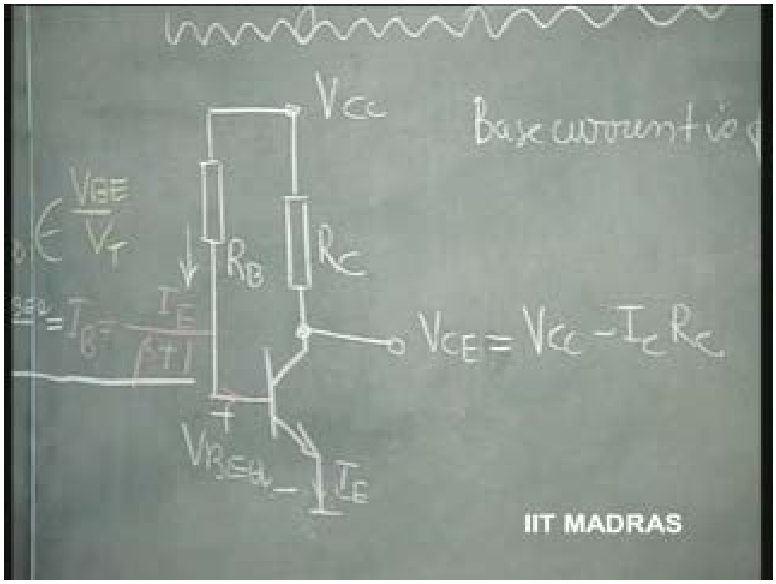


This is a good way of biasing.

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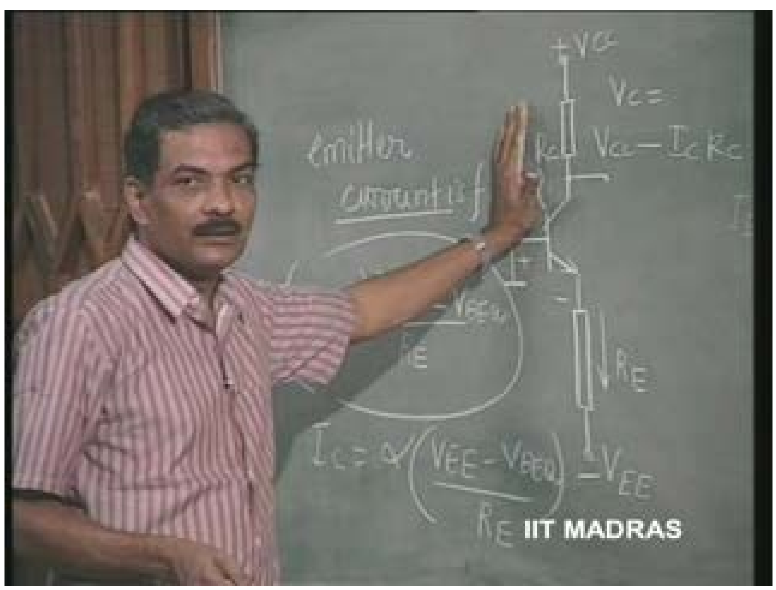


But, what is the penalty? In this case, you are using a single supply; in this case you are using dual supply. But, we can have a compromise between this and this by using essentially both base resistance and emitter resistance. Suppose I decide that there shall be base resistance as well as emitter resistance. Then, I have a choice possible, in biasing this circuit.

So, we will go next to that way of biasing using a single supply, which can still be made stable. So essentially, we have now, we have discussed two extreme situations: this is common emitter biasing scheme, this is common base biasing scheme. Base is the common point for the D C voltages as well as A C. Here, emitter is the common point. Here, we have, we can manage with single supply; we have to have dual supply in this case.

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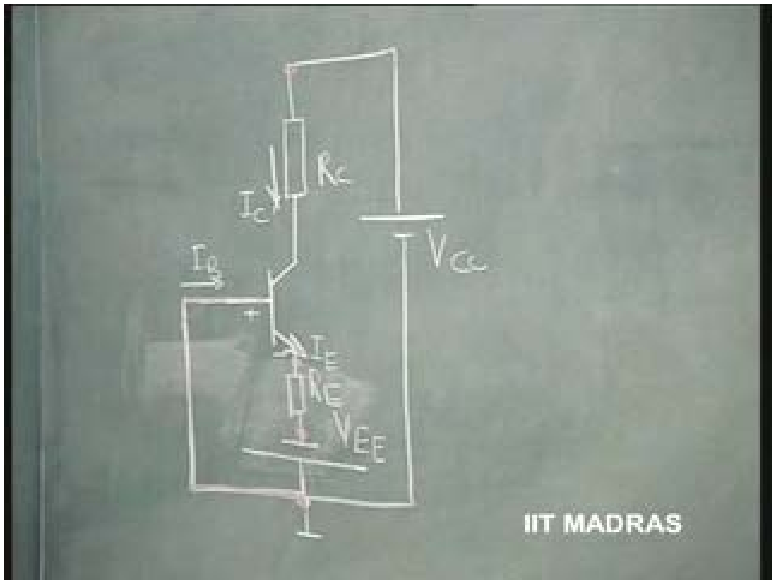


Just now we said, making the base common, making the base common, we can use a negative supply and a positive supply; the positive supply to reverse bias, the negative supply to forward bias; this n p n transistor. So, I have essentially redrawn, with these batteries actually put there, instead of indicating minus and plus as previously. This is just to depict that this configuration within this loop has, V E E and R E and V B E Q, within this loop.

Within this loop of course it has V C C, R C, R E and V E E. So anyway, this battery forward biases this; this battery reverse biases this. Now, this arrangement essentially can remain as such as far as this loop is concerned. If I put this battery instead of here, I will put it... this should be positive and this should be negative, and short circuit this.

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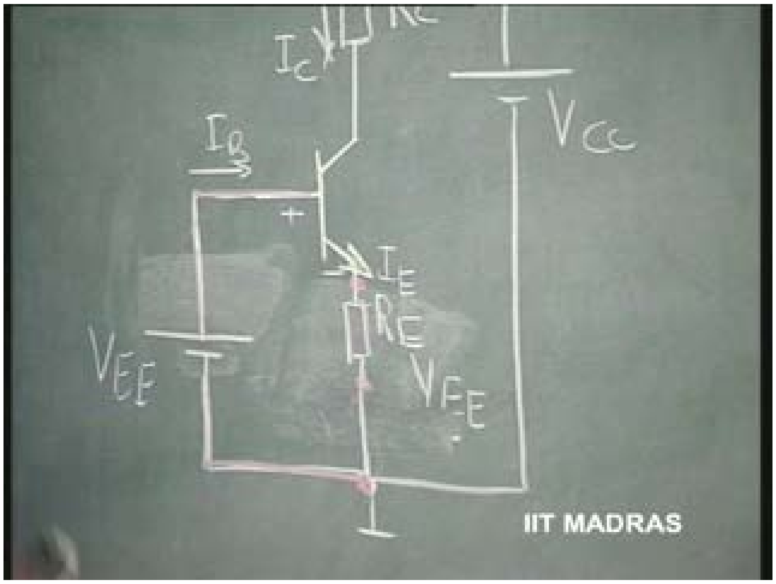


So, as far as this loop is concerned, nothing has changed. In fact, it will be V E E, same V E E. So, the equation is, at the input is, going to be the same as previously written; V E E minus V B E Q divided by R E is still the current, I E. The only thing is, in this, this V E E which was earlier present, is absent.

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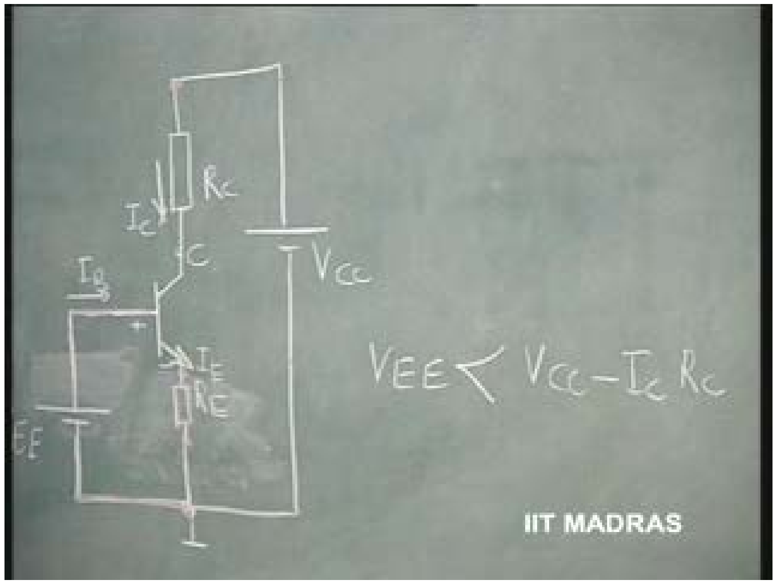


So now, you can see that I can therefore still bias in a stable manner using two power supplies; but these two power supplies have to be necessarily different because, this is V E E, an ideal supply, and this V C C has to be obviously greater than V E E because this collector potential should be greater than the base potential here. So, I cannot use for this V E E, same voltage as V C C. That is a problem. So, V E E here has to be less than what? – V cc minus I C times R C; that is the collector potential.

In order to reverse bias the transistor, this V E E has to be less than V C C minus I C R C. So, I cannot use dual supplies saying that this is 10 volts and this also shall be minus 10 volts, and just put that minus 10 volts as plus 10 volts. That will not work here. That is because I require a reverse bias voltage here. So this, for this reason therefore, I can still use this supply in order to derive a supply which is less than V C C. By Thevenin's equivalent, I can now... so, if I now see the voltage here, open circuit voltage, it will be R 1 by R 1 plus R 2 times V C C.

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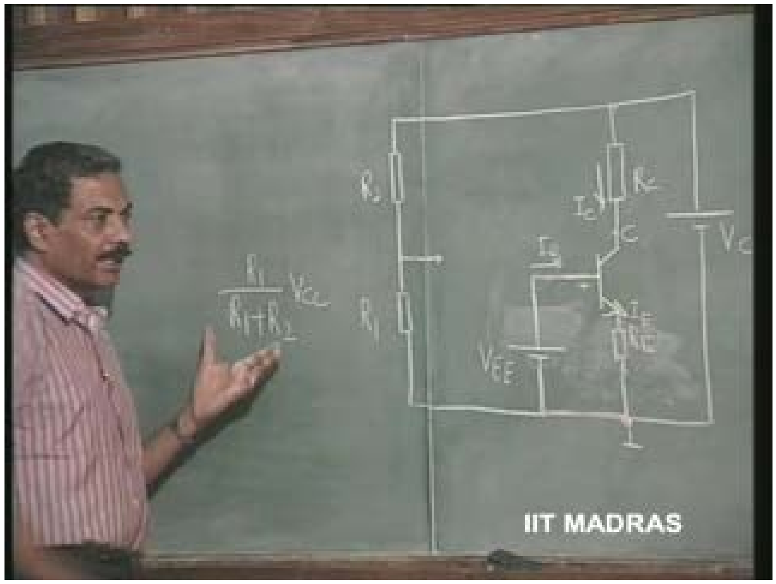


So, I can get any voltage which is still positive and less than V C C minus I C R C by appropriately selecting R 1 and R 2. But the only trouble is, it is...this is the Thevenin's voltage here; but there is also a Thevenin's resistance in series with this Thevenin's voltage, the moment I use R 1 and R 2, which is equal to R 1 parallel R 2.

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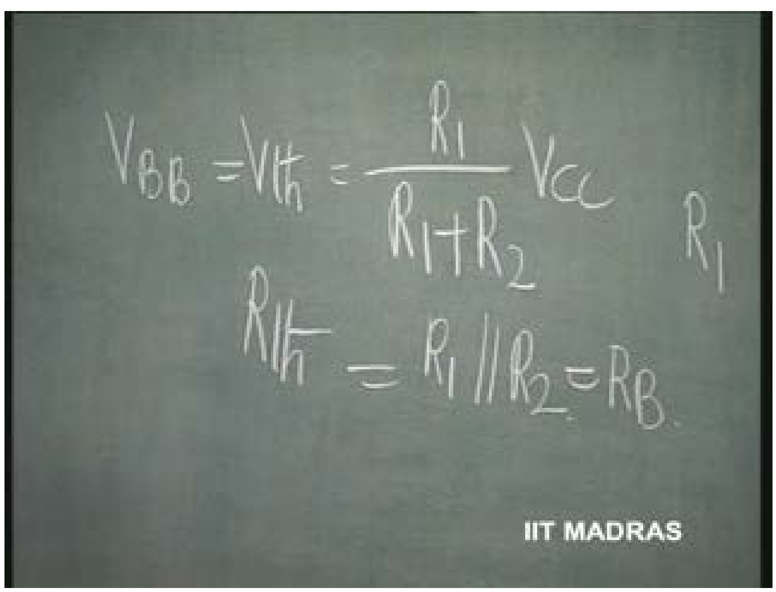

So, this R 1 parallel R 2, we will call this as RB; and this Thevenin's voltage as VBB, is what is going to appear here, if I connect it up this way; which means, this is equivalent to a battery which is VBB of magnitude this way, V C C into R 1 by R 1 plus R 2, in series with R Thevenin's, or R B, now we are calling it, which is the same as Thevenin's equivalent resistance, which is R 1 parallel R 2.

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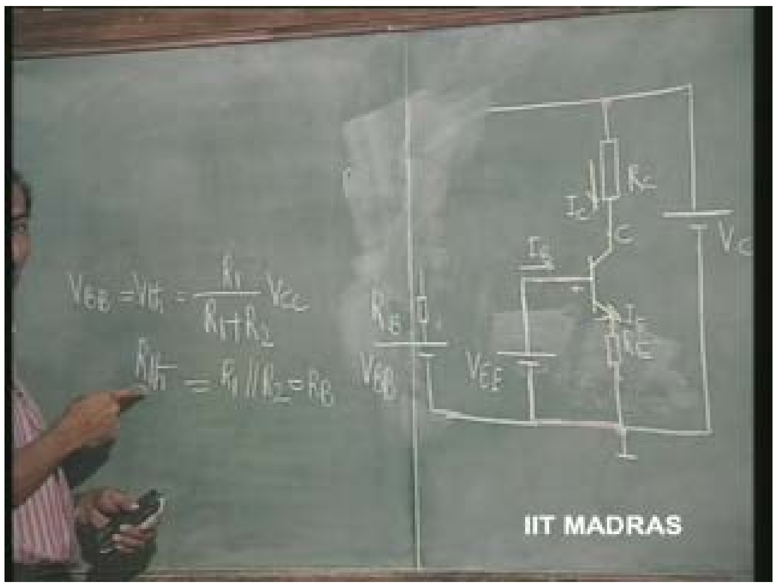


So, it is not an ideal battery as envisaged here. So, there is a series resistance R B. Actually, we would like to have R B as zero in order to do the stable biasing; but it is not so. So, let us see how this compromise circuit will work. So, I am removing this battery V E E and replacing it with this kind of arrangement.

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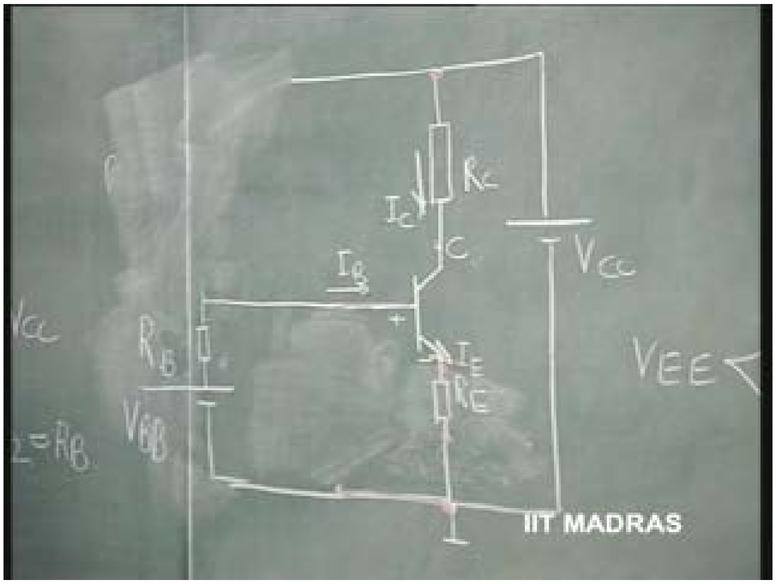


So, instead of a battery with the emitter resistance, I have a battery in series with R B, which could be made as small as I please because, that is my choice, by selecting R 1 and R 2 appropriately, and then this value. It is a... it is a must that R B should be very small, compared to what? This is important.

That means the voltage here should be essentially VBB. The drop in R B should be negligibly small. What is the drop in R B? The drop in R B is nothing but I B times R B because I B is flowing this way. So, actually speaking, the voltage V B is going to be equal to V B B minus I B times R B. So, this should be very small compared with what? – this drop comes here and that is now going to be essentially V B. And this is going to be dropped across this as well as this. So, this is going to be equal to V B E Q plus the drop in this, I E times R E.

See, in order that we have a stable biasing as envisaged earlier, this should be small compared to this, I E R E. That means, I B R B should be much less than I E R E. This is a stable way of biasing.

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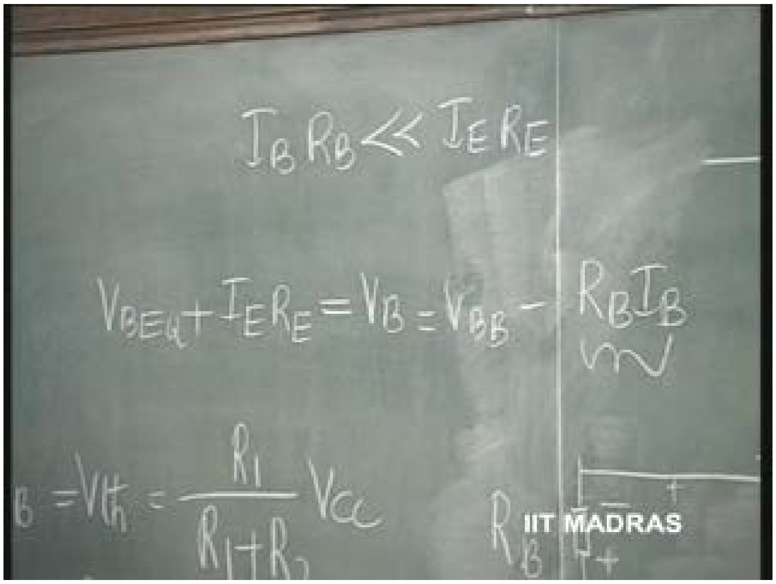


Have you understood this concept? That means, if I B R B is much less than I E R E, I can ignore this and essentially we have the same equation. I E is going to be now fixed as VBB minus V B E Q by, let us say, R E; the same expression as earlier, right? And, I C is going to be equal to Alpha times I E.

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So, how do we select this? We know. What is I B in terms of I E?

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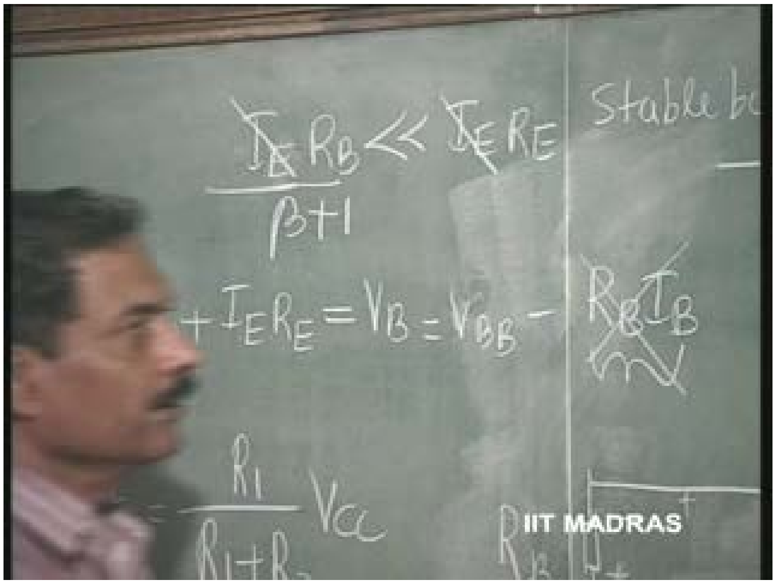


I B is I E divided by what? – Beta plus 1; I B is I E divided by Beta plus 1. So, this relationship, you can cancel this; and this is an important relationship in biasing – that, you must select R B which is going to be much less than R E into Beta plus 1.

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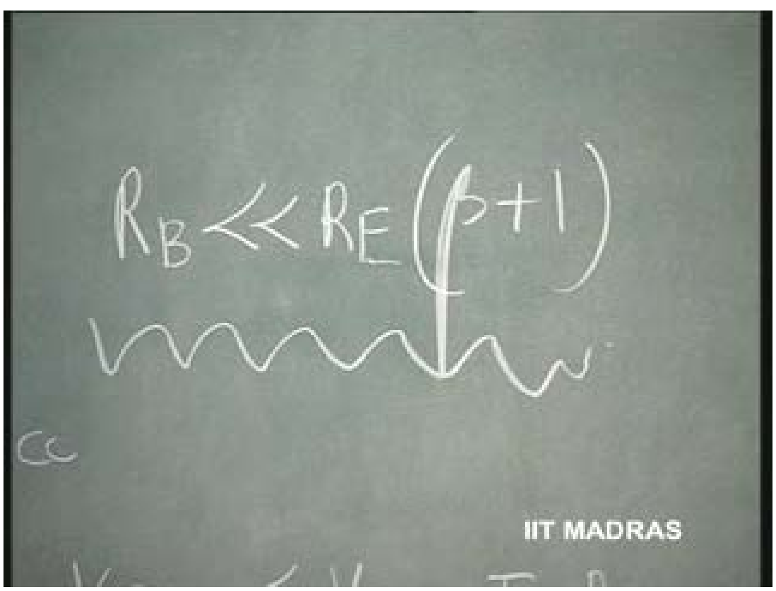

That means R 1 parallel R 2 which is R B shall be so chosen; that means, R 1 R 2 by R 1 plus R 2 which is R B should be much less than R E into Beta plus 1.

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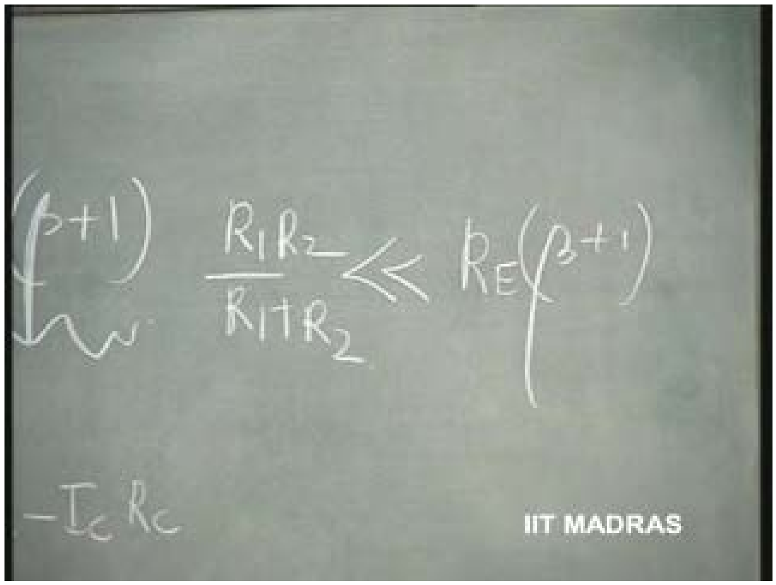


This is easy because Beta is very high. Suppose R E is of the order of Kilo ohms; Beta is, let us say, 199; so, 200 Kilo ohms. So, R 1 parallel R 2 need be much less than only 200 Kilo ohms. That means even when R 1 parallel R 2 is of the order of 20 Kilo ohms, this is satisfied.

So, this kind of design is what is going to work satisfactorily for biasing this transistor in a stable fashion. But now, please see here, nothing is common here. Base has been lifted, emitter has been lifted, collector is already lifted. So, base, emitter, collector, all at certain D C potential with respect to ground. So, this is a general configuration wherein we can bias the circuit in a very stable fashion.

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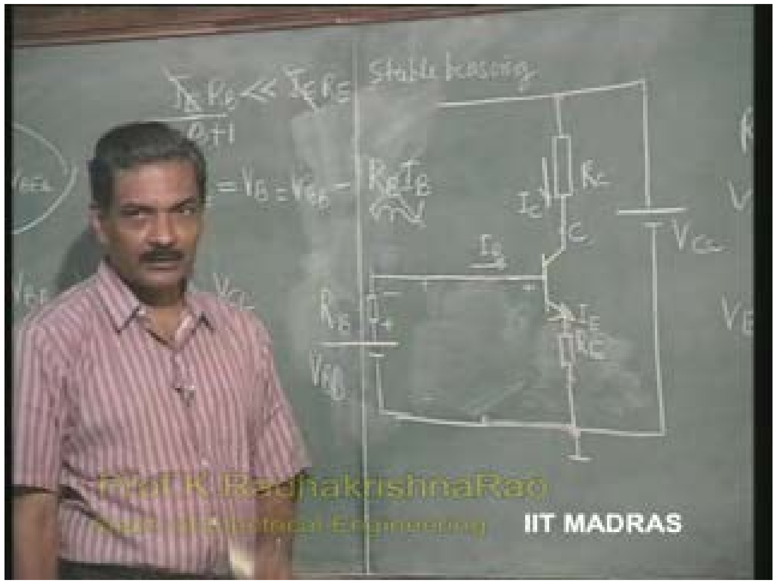


So, let me take an example. V C C is equal to still, let us say 10 volts and I want, let us say V C B equals 5 volts. I want V C C equal to 10 volts, V C B equal to 5 volts and I C should be equal to 1 milliampere, let us say. So, design an appropriate circuit so as to have all these conditions.

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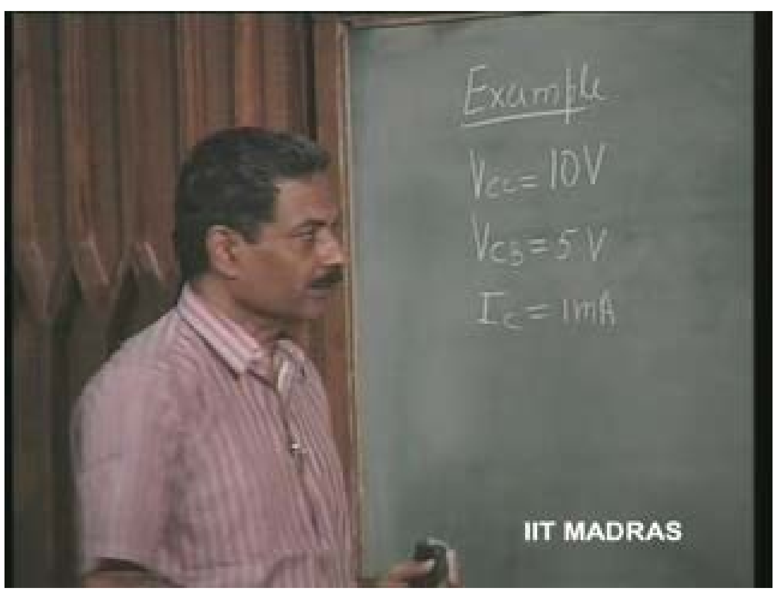

The transistor characteristic is not clearly known; which means this kind of biasing should be possible, whatever be the transistor I use. So, we have 10 volts being used. Example 8. So, 10 volts being used. Let us put an R C here and I C equal to 1 milliampere. So, what will be the R C? Because, this and V C B. V C B is this voltage. This shall be 5 volts, this is 10 volts. This is going to be about point 6 volts, 5 point 6. So then, I can have an R E which is unknown; and then, an R B which is also not known; and V B B for biasing this. This is going to be R C which is not put.

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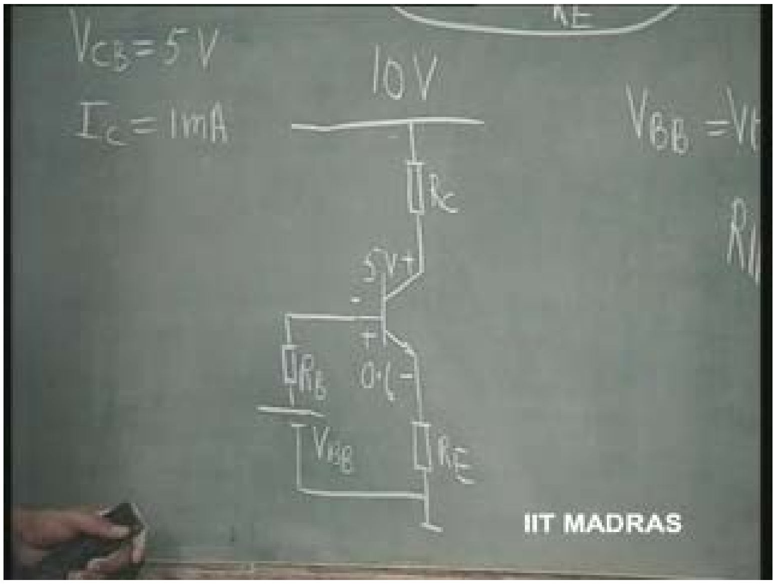


So please... now, what is specified is that this is 10 volts and the current I C is equal to 1 milliampere. Then, I will take, let us say, Alpha as point 995, let us assume. That means Beta is 199. So, you can say that I C is very nearly equal to I E because Alpha is point 995. So this, if it is 1 milliampere, this also is going to be around 1 milliampere. This voltage is 5 plus point 6; so, this is 5 point 6. This is 5 point 6. This is 10 volts. So, what is the effective drop in R C and R E? 10 minus 5 point 6. So, 10 minus 5 point 6 is equal to 1 milliampere; into R C plus R E, assuming that I C is equal to I E.

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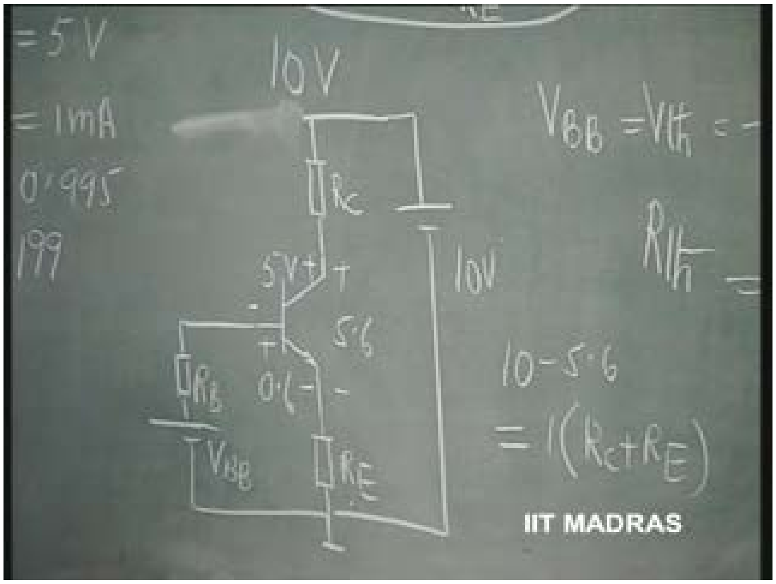


So this, in this loop, if you write down the Kirchhoff's equation: 10 minus 5 point 6 is equal to I C, which is equal to I E, let us say, into R C plus R E. So, we get, R C plus R E as equal to 4 point 4 K. So, let us say, we will take R C as about 3 K and R E as equal to, say, 1 point 4 K. This is now looking somewhat arbitrarily. This depends upon what kind of load resistance you should have. So, R C is equal to 3 K and R E is equal to 1 point 4 K is a solution here.

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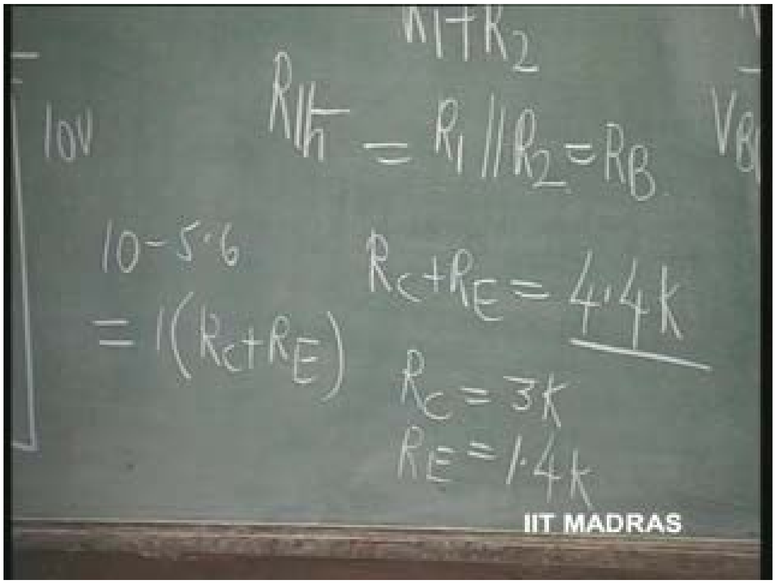

If you do that, then, this is 1 point 4 K; and this is 3 K. So, 1 point 4 K into 1 milliampere is 1 point 4 volts drop here, plus point 6; so this voltage is going to be 2 volts – 1 point 4 volts across this and point 6. So, this is at a potential of 2 volts. If I ignore the drop in R B, then V B B shall be equal to 2 volts. So, V B B is now known to be very nearly equal to 2.

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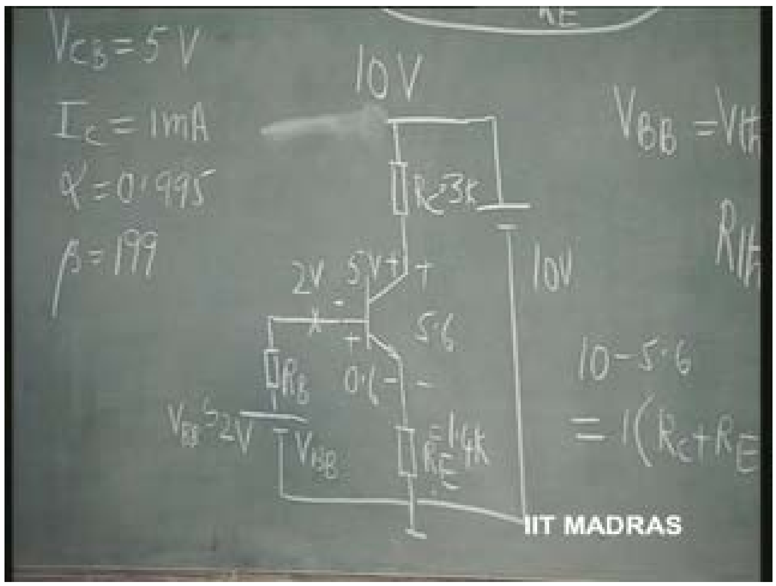


So, you know the Thevenin's voltage. So, once you know the Thevenin's voltage, that is R 1 by R 1 plus R 2 into 10 volts is equal to 2 volts; that is the Thevenin's voltage. So, R 1 by R 1 plus R 2 is equal to 1 by 5. So, we have five times R 1 equals R 1 plus R 2; or, 4 R 1 equal to R 2. That is another condition to be satisfied.

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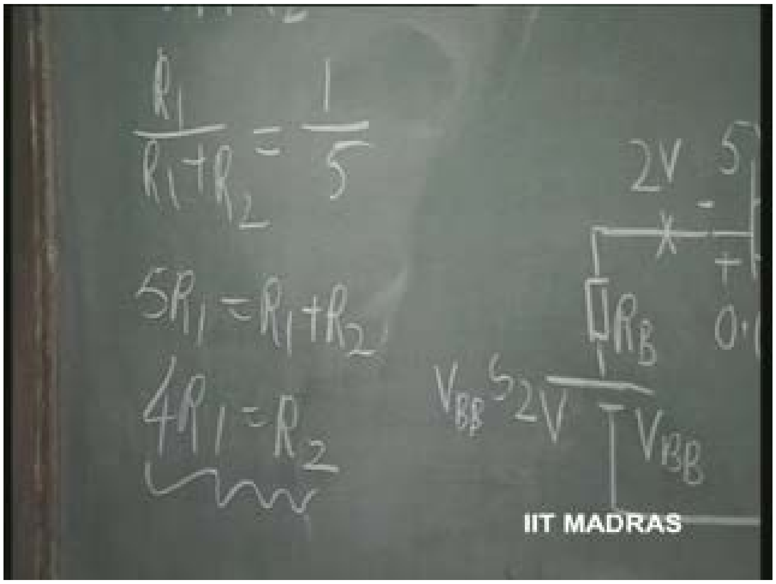


And, how do I select R 1 parallel R 2? That we already know. R 1 parallel R 2 shall be much less than... Beta plus 1 is 200, in this case, into R E, 1 point 4 K. That means much less than 280 Kilo ohms. So, let us take it as 28, or, let us say, 28 Kilo ohm. Anything less than 28, that satisfies this relationship. So, let us say, any resistance which is less than 28 K.

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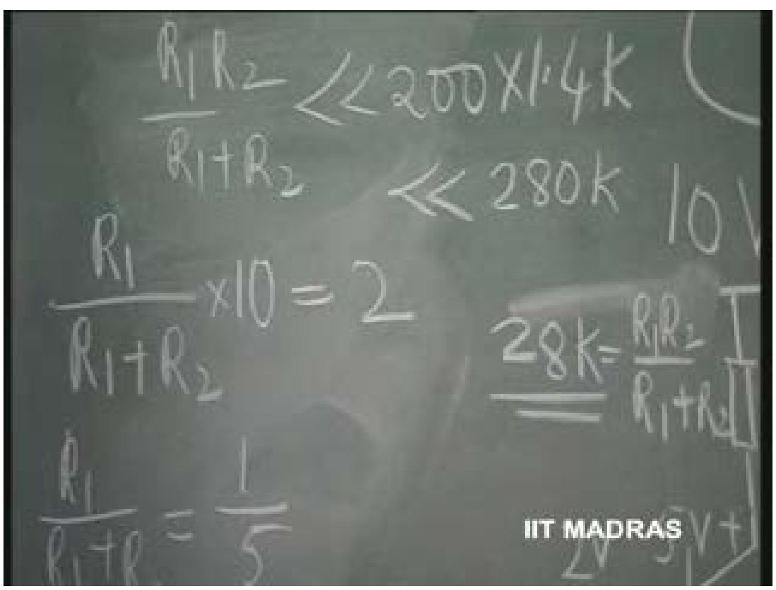

So, R 1 parallel R 2 is... you know R 1 parallel R 2 is 28 K. R 1 by R 1 plus R 2; or, 4 R 1 is equal to R 2. Now, you can substitute for R 2 here and get the value of R 1.

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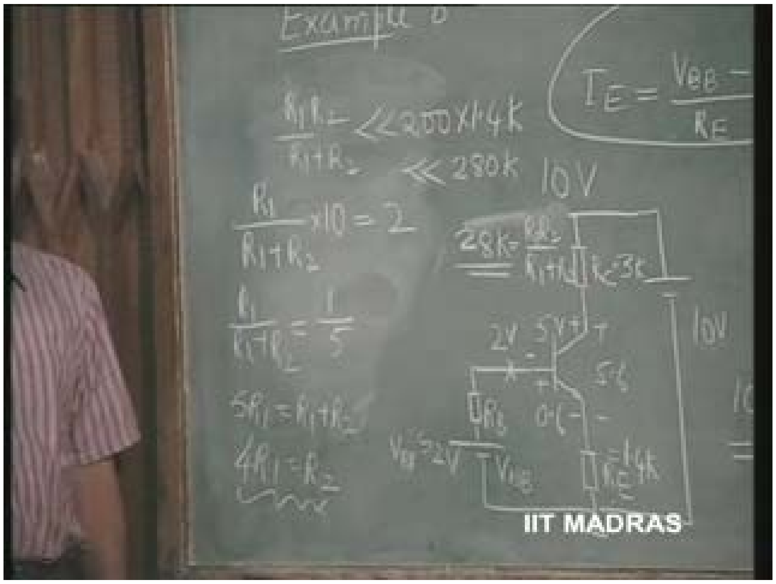


So, I will leave it to you. Find out the value of R 1 and R 2 and come to the next class. This is one relationship; this is the other relationship. So, that will fully satisfy this biasing arrangement and therefore you can again redraw this structure with R 1, R 2, V C C, R C and R E. That is the complete structure. So, I would like you to evaluate R 1 and R 2 and redraw the biasing circuit.

In the next class, we will give you the complete circuit. Please try to attempt this in your hostel.