So, this R_{B2} as it is giving the information of the output voltage to its base we may say that it is working in feedback connection. However, you need to be careful that while this R_{B2} connected to the output node it is providing a –ve feedback to stabilize the operating point and it ensures that the operating point it is easily achieved. Namely it ensures this $I_{C1} = I_{C2}$ easily, but at the same time there is a chance that this R_{B2}; it may feed the signal back to this transistor and it may and that may reduce the gain of the circuit. To avoid that, we put some extra capacitor here.

So, that the v_{be} voltage or v_{be} voltage of transistor-2 signal wise it remains 0. At least in the mid frequency range this additional capacitor; it ensures that this this transistor it is really working only for giving the support not for any amplification or any feedback operation in the mid frequency range ok. So, if you consider it is a small signal equivalent circuit which is shown here in the next slide yeah.

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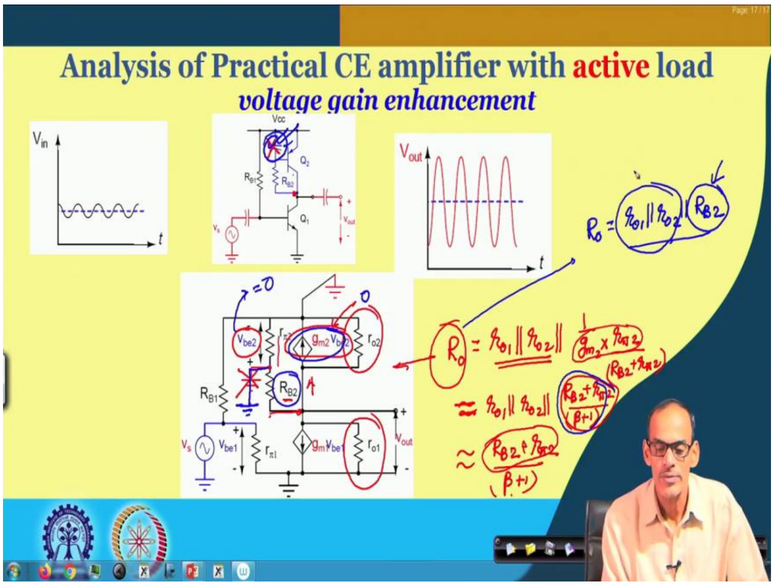

So, this is what the discussion here that if we connect this R_{B2} here; that means, this R_{B2} it is connected here it is not connected to ground. So, if we do not put this capacitor here then naturally then it will be providing one nonzero value of v_{be2} as a result this current it will be flowing as a non-zero entity. And there is a consequence in fact, looking into this circuit this active device it will provide additional conductance.

So, the output resistance it is not only r_{o1} and r_{o2} coming in parallel. In fact, for this circuit if I do not consider this capacitor and hence if I do not consider this connected to

AC ground, then R_o you can find that this is coming in equals to $r_{o1} \mathbin{/\!/} r_{o2} \mathbin{/\!/} \frac{1}{\frac{g_{m2} r_{\pi 2}}{R_{B2} + r_{\pi 2}}}$. In fact, you can simplify it further you can consider this = β. So, that = $r_{o1} \mathbin{/\!/} r_{o2} \mathbin{/\!/} \frac{R_{B2} + r_{\pi 2}}{\beta}$. In fact, if I also need to consider this path.

So, it may be even the additional one also. And this is equal and that becomes primarily dominated by this and it may be reducing the output resistance drastically. And the consequence is that if the output resistance it is drastically getting reduced from whatever our original target of $r_{o1} \mathbin{/\!/} r_{o2}$ only that will drastically that may affect the gain. In fact, that will affect the gain drastically.

And that makes the even though the active circuit we may call it is active circuit gain of the circuit it may go back to the previous circuit. Numerically we will see that how if I consider practical value of this R_{B2} and then β then, we will see that gain it may not change much compared to common emitter amplifier with passive load. So, to overcome this problem what we are considering now it is, we are putting this circuit here. And the moment we put the circuit there it is basically we are making this is ground and that makes this $v_{be} = 0$ and that makes this part equal to 0.

And that makes this circuit going back to the previous one except of course, this R_{B2} it will be coming in parallel. So, instead of this part if I put the capacitor bypass capacitor here then the corresponding R_o it will be $r_{o1} \mathbin{/\!/} r_{o2} \mathbin{/\!/} R_{B2}$. Well, even though in this case this R_{B2} it is coming in parallel with r_{o1} and r_{o2}, but we know that the typically value of this base resistor it is quite high. And all practical purposes it may remain unchanged almost unchanged and hence the gain of the circuit it will be very good.

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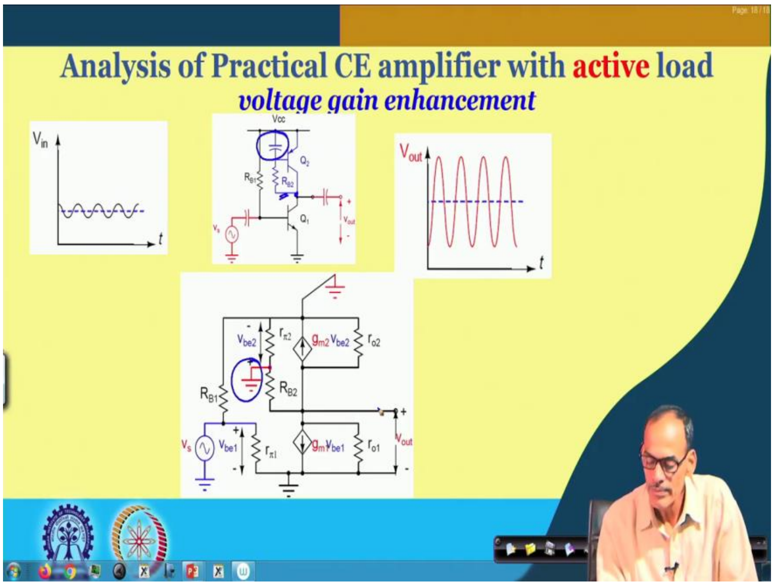

So, in summary of this modification what we like to say here it is. In this case by making the connection of this R_{B2} to the output node, we are making the operating point easily achievable. And then to avoid it is adverse effect on the gain namely the reduction of the gain we are putting this extra capacitor which is making the base node of transistor to ground and hence the corresponding gain it is remaining high. So, numerical value we will see it later.

So, similar kind of practical circuit can be obtained for common source amplifier also.

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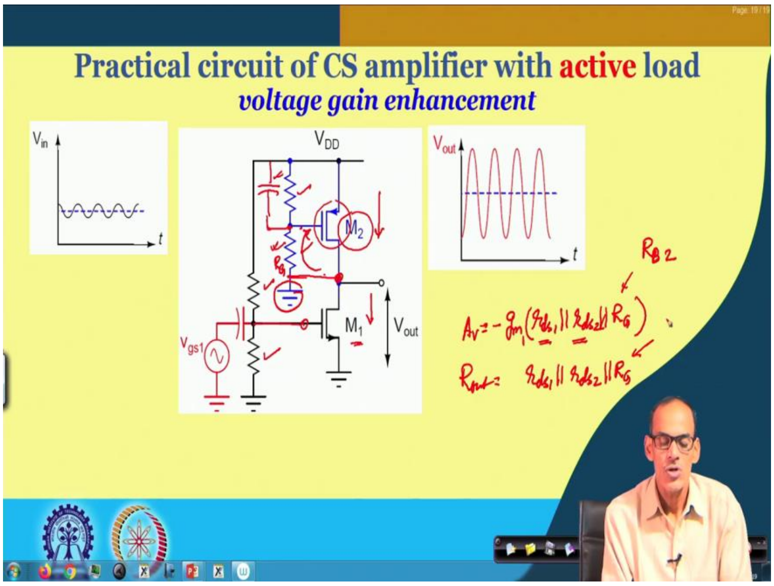

This is what it is shown here. I will not be going in detail, but just to say that we do have say one resistor here. We do have another resistor here to define the gate voltage of transistor-1 and likewise we do have two more resistors here to define the gate voltage of transistor-2. And then we have to ensure that these two I_{DS} and I_{SD} they should be equal and both of the transistors should be in saturation region.

Now, to avoid the fine tuning and all or rather to get this condition easily achievable instead of connecting this to ground we can connect this to output node. But then again we must be aware that, the moment we connect this resistor to the output node it may feed the signal back here and that may reduce the gain of the circuit because that reduces the output resistance. To take care of that you can put here AC grounding capacitor making the signal coming back here it is bypassed and making the active part of this device equals to 0.

And then we can get the high gain and for this case if you put this resistor and if I call this is a R_G just R_G; then the voltage gain for this case it will be $g_{m1}(r_{ds1} \mathbin{/\!/} r_{ds2} \mathbin{/\!/} R_G)$ with a – sign. And the output resistance it is $(r_{ds1} \mathbin{/\!/} r_{ds2} \mathbin{/\!/} R_G)$. In fact, if you if you see the previous circuit also, now if it is BJT there we have seen similar kind of things namely this was r_{o1} this was r_{o2} and this was R_{B2} and same thing for this also instead of R_G it will be R_{B2}.

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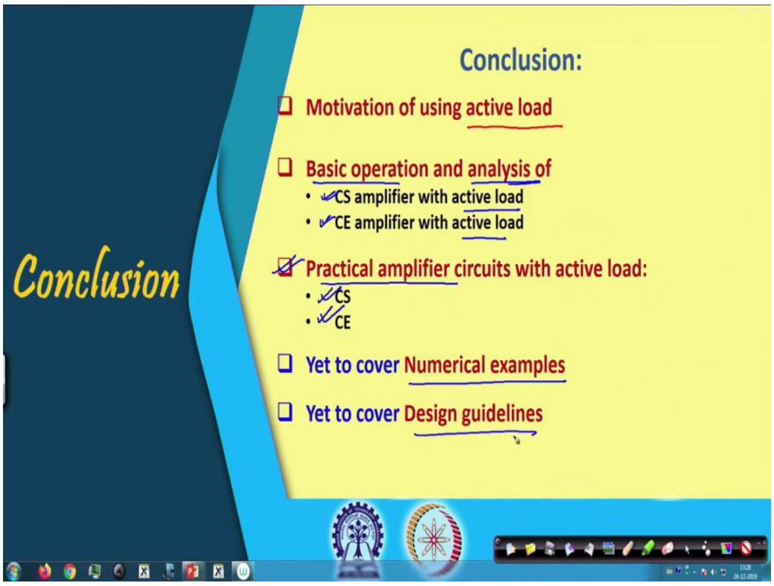

So, we need to cover the practical circuits. So, that will be covered in the next class. So, in conclusion what we have covered today it is, we started with basic motivation of going into active load. Namely in improving the performance specifically the voltage gain of common emitter and common source amplifier and then we have discussed about the basic operation of common source and common emitter amplifier having active load. And then we have done the analysis to get the expression of voltage gain.

And then output resistance for considering the idealistic bias condition. And then we have discussed about practical amplifier circuit where the operating point is possible and achievable with active load. And then we have seen the consequences or at least we have highlighted the consequences. Namely the gain may get affected by those practical circuits having feedback. And then we considered bypass capacitor there to avoid the adverse effect on the gain. And the other two things we yet to cover it as on this topic is that numerical examples may be little bit on the guidelines, but that will be covered in the next class.

Thank you for listening.