transistor, it is connected to AC ground then it is not only it is r_o and this r_o coming in series in fact, we do have some nice amplification here ok.

So, this kind of tricks can be utilized to make the impedance here much higher than normal r_{o1} which is referred as cascode current source, later we will be talking about that in detail. So, while you are talking about cascode amplifier, this cascode terms it may be coming while we will be you know designing this part to achieve high value of this impedance R_3. So, anyway so, that is the output impedance we do have R_3 in parallel with this and then coming to the input impedance. Let me clear the board yeah.

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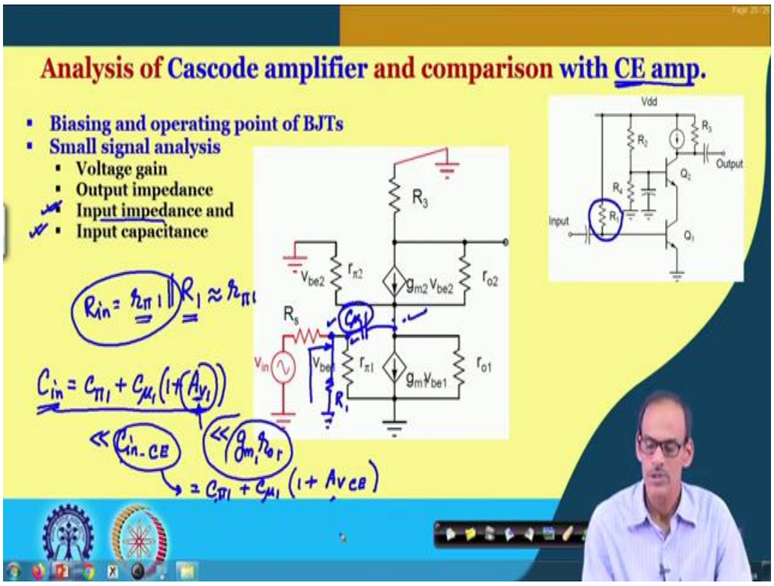

So, the input impedance on the other hand so, if you see this is the input port input impedance is very straight forward. So, R_{in} it is same as $r_{\pi 1}$, but then input capacitance. So, this is very important thing. So, input impedance wise if you see hardly there is no difference compared to input impedance of normal CE amplifier. In fact, we also need to consider R_1 in parallel with that, but. So, this R_1 in this model I have not drawn you can draw that one also. So, typically this R_1 it is much higher than $r_{\pi 1}$.

So, you may consider this is approximately equal to $r_{\pi 1}$ which is same as the input resistance of normal CE amplifier. So, I should say there is no change in input impedance; however, in input capacitance if you see the C_μ this C_μ it is which is integral part of Q_1 which is breezing the base and collector terminals of Q_1.

Now from this node to this node we claim that the gain of the circuit is not very high. So as a result the miller factor coming for this $C_{\mu1}$ it may not be very high. So, of course, you will be getting $C_{\pi1}$ and then $C_{\mu1}$ (1 + A_{V1}, gain) and we claim that this A_{V1} gain, it is much lower than $g_{m1}r_{o1}$. So, if we if we agree with this are much lower than $g_{m1}r_{o1}$.

So, we can say that this capacitance is much smaller than C_{in} or a standard CE amplifier, where for standard CE amplifier the corresponding input capacitance is $C_{\pi1}$ + $C_{\mu1}$ (1 + the corresponding voltage gain of CE amplifier). Now to really acknowledge the improvement of this input capacitance namely reduction of the input capacitance, we need to establish that this gain the circuit gain here from this point to this point it is much lower than the voltage gain of CE amplifier.

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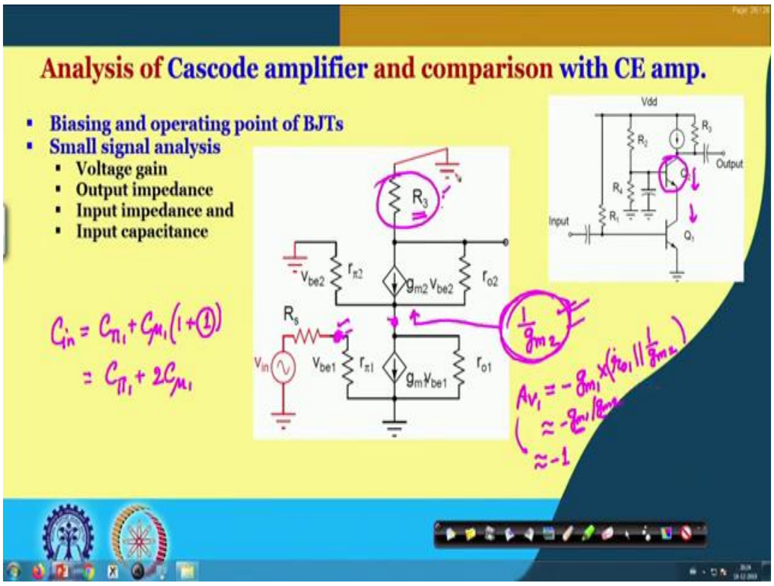

So let us see how we establish that. So, if you see this circuit if you see this circuit and if you want to know what will be the gain from here to here, we need to know what is the corresponding impedance we do have here and we have seen that based on the value of this R_3 this impedance maybe in the order of you know $\frac{1}{g_{m2}}$.

So, the voltage gain from here to here it is I should say A_{V1} if I call it is A_{V1}, $- g_{m1} \times$ (r_{o1} coming in parallel with whatever the impedance). We are seeing here and that may be in the order of $\frac{1}{g_{m2}}$ ok. So, this is approximately $\frac{g_{m1}}{g_{m2}}$ and since the current here and current here they are same, we can say that g_{m1} and g_{m2} they are same. So, further we can say that this is approximately minus 1. So, that makes the input capacitance of this circuit it is $C_\pi + C_\mu$ (1 + 1) or to be more precise $C_{\pi 1} + 2C_{\mu 1}$.

Here of course, we have assumed that this input impedance the input impedance of the cascode transistor this is referred as the cascode transistor so, it is in the order of $\frac{1}{g_{m2}}$, but we know that it depends on it highly depends on the value of R_3. So, if this R_3 on the other hand if it is very high that may increase the increase this resistance and the consequence here of course, then the voltage gain here it will increase. So, here to here the voltage gain if it is increasing, then this factor instead of one that will also increase.

So, but then typically this gain from this point to this point it is, it is quite fair to approximate that that is gain it will be around 1 or 2 depending on this corresponding load practical load here. Let me take a short break and I will come back after the break for the MOS circuit.