Analog Circuits
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Module - 07
Lecture – 08

We have now looked at biasing of a transistor at a given drain current quiet in detail for both the pMOS and nMOS. And we have seen that the feedback can be completed in various ways. In this lesson, we will look at some more alternatives to this. Of course, there is no end to this the way you complete the feedback around a transistor, there is an endless variety, but we will take a few of them for illustration. And actually these circuits will be useful not just for biasing; it turns out that if you apply inputs at the appropriate places and take the outputs at appropriate places, you will also have useful functionality.

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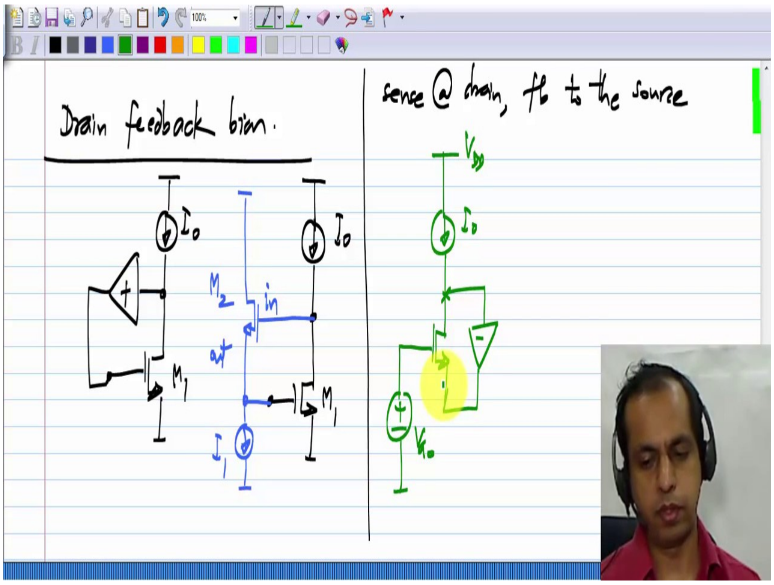

So, first let me consider drain feedback biasing. What do we do, we have a transistor; let me call it get M_1 . We connect a current source I_o to the drain and we have to complete the feedback with some positive incremental gain to the gate from the drain to the gate. Now what is the circuit that we know which has the positive incremental gain, many circuits certainly the common drain amplifier or the source follower that is an example and the common gate amplifier is also another example. So, let us take the common drain amplifier or source follower.

Now, I have this part and I want to complete the feedback using a source follower. So let me do that let us say the source follower is bias gate at current I_1 then as far as the source follower is concerned that is the input and this is the output and the incremental gain is almost one . So, I can complete the feedback like this. So, many times you see composite structure using two transistors, but you should not get confused this is the source follower and it is completing the drain feedback around this transistor. Now. you can also apply signals to various places and some functionality that you can see in the examples and the assignment.

So, let me call this M_1 and this will be M_2 . Now we can take another example where we sense at the drain and feedback to the source; in this case, what do we do, with the gate is tied to some fixed voltage V_{G0}, this is I_o because the sense of variation we want at the sources is opposite to what we get at the drain. We have to complete the feedback through a negative incremental gain.

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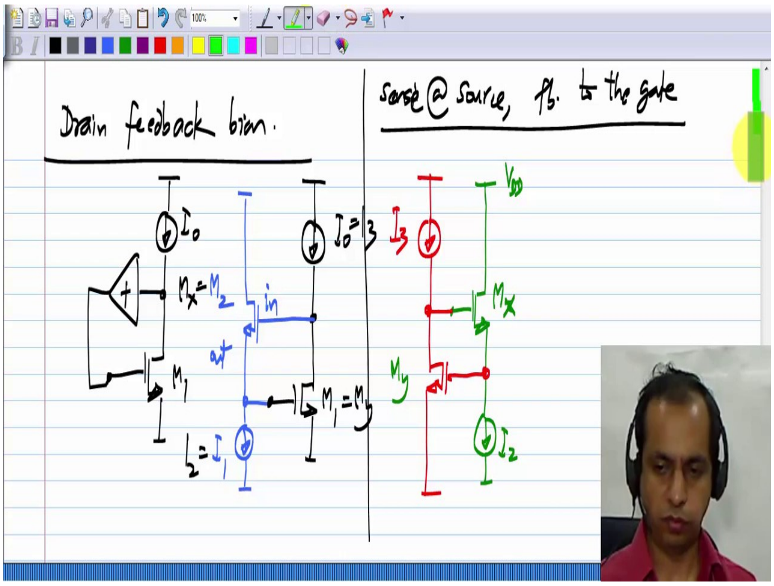

Let me take another example of sense at the source and feedback to the gate. In this case, to sense at the source, we have a current source, let me call it I_2, it just to distinguish between things. The drain is connected to the supply voltage and because the sense of variation we want at the gate is opposite to what we see at the source. We have to complete the feedback through a negative incremental gain. Again let us try some possibilities for this negative incremental gain, what possibilities do we have, one obvious thing is a common source amplifier. The very first amplifier that we discussed, it has negative incremental gain. So, let me use a common source amplifier in this place so that is the common source amplifier, and I complete the feedback that way. Let me call this I_3, and maybe I will call this M_x and M_y.

So, how did we come about this circuit, we wanted to bias M_x at a current I_2, we complete the feedback to the gate through a negative incremental gain, which is a common source amplifier using M_y. Now, if you look at these two circuits they are exactly the same. So, if you make this correspondents M_1 is the same as M_y in other case; a M_2 is the same as M_x in the other case; I_o serves the function of a I_3 here and I_2 is I_1. Do not worry about the values, but you see that topology here is exactly the same as the topology over there. So, in this case, we think of this transistor being biased using drain feedback, we feedback from drain to the gate.

In this, we think of biasing this transistor by feedback from sources to the gate. So, either point of view perfectly valid. Once you have a feedback loop, all components in the feedback loop have feedback around them. You can choose any one transistor and say the other transistor is helping to complete the feedback loop. So, this was just to illustrate to you also that you can think of the circuit in different ways, but arrive at same circuit.

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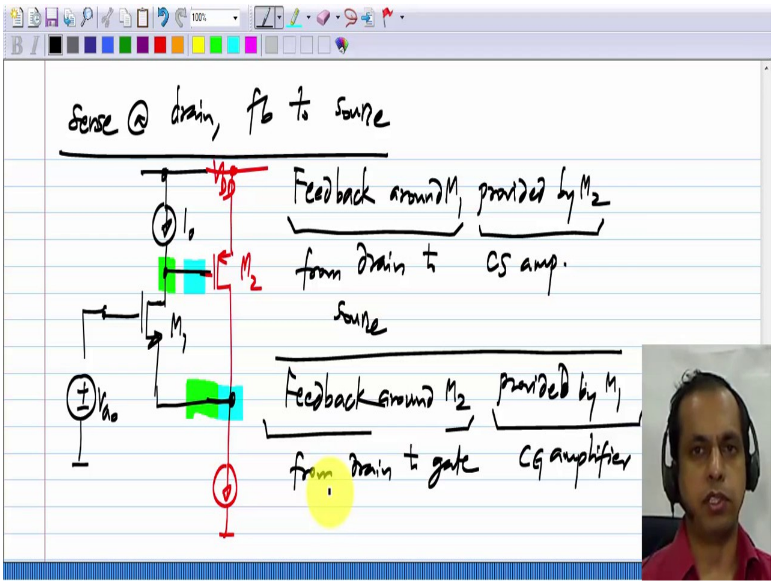

Let us take a couple of more examples. Let say we sense at the drain and feedback to the source, because the sense of variation, we need at the source is opposite to what we have at the drain, we have to complete the feedback using a negative incremental gain. And what could I used for a negative incremental gain, I could use a common source amplifier and this time just for fun let me use a pMOS common source amplifier. A pMOS common source amplifier is this, and I complete the feedback loop that way.

So, this colouring makes it obvious, this is completing the feedback loop around that transistor. Let me call this M_1, and this one M_2. So, there is huge number of variants and in every circuit, we can swap nMOS for PMOS and so on. So, this is the another example and in every case it is not important that you know every topology beforehand once you were given a topology, you should understand what it is doing. First of all you should be able to recognise this feedback should be able to see that there is feedback from drain of M_1 to the source of M_1. Or if you think of M_2 as the central actor then you can see that there is feedback from drain of M_2 to the gate of M_2 through this and what is this, this is the common gate amplifier.

So, you can think of feedback around M_1 provided by M_2; feedback around M_1 meaning from drain to source; and M_2 is a common source amplifier, and the same circuit can be equally well thought of as Feedback around M_2 meaning from drain to gate provided by M_1, which is a common gate amplifier. So, both points are equally valid. Now, what is also important is you should be able to put down the incremental picture of these things or if some other bells and whistles are added to these circuits including those components and analyze. I mean normally you will have some input and some output and you may ask to calculate the transfer function or maybe the input resistance somewhere and so on. All these things, you can see in the examples.