

Analog Circuits
Prof. Nagendra Krishnapura
Department of Electrical Engineering
Indian Institute of Technology, Madras

Module - 02
Lecture – 09

Another point to note is that I_D is $\mu_n C_{ox} W$ by $L V_{GS} - V_T$ times $V_{DS} - V_{DS}^2$ square by two in triode region, that is V_{GS} greater than V_T and V_{DS} smaller than $V_{GS} - V_T$. Now if you assume that the drain source voltage is very small, V_{DS} much smaller than $V_{GS} - V_T$, this I_D will be approximately you can neglect this square term in comparison to this right, because this whole term is $V_{GS} - V_T - V_{DS}$ by two times V_{DS} , and I am neglecting this term, assuming this approximation. So, I_D is approximately $\mu_n C_{ox} W$ by $L V_{GS} - V_T$ times V_{DS} . So I_D varies linearly with V_{DS} , and this is why it is called the linear region. I_D vary approximately linearly with V_{DS} , when V_{DS} is very small. So for this reason, this is called the linear region.

This set of values, this is called the linear region of the MOS transistor. And it turns out that this also has some applications, because V_{DS} is the voltage applied between these two terminals, and I_D is the current flowing from drain to source, this is reminiscent of having a resistor where you apply a voltage between two terminals and you have a current flowing from one terminal to another.

And in a resistor, this current is linearly dependent on the voltage. And in the triode region, with this approximation the drain current I_D is linearly dependent on V_{DS} , but the important thing is the constant of proportionality here, which is the conductance of the MOS transistor, I will call it G_{mos} is dependent on V_{GS} . So this is an electronically controllable resistor. By changing V_{GS} , we can change the conductance between drain and source, so sometimes it is used for that purpose.

MOS transistor in triode region is a voltage controlled resistor. In general, anything that is electronically tunable is useful, because you can use it for some useful function in the circuit. You know, first of all, even without knowing a lot of details of electronics you know that lot of

things are electronically controlled these days and an electronically controlled resistor is also useful in a similar search.