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Transistors

NOT

AND and OR

NAND and NOR

XOR and XNOR

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Intro

PMOS

NMOS

Razavi Electronics 1, Lec 29, Intro. to MOSFETs - Razavi Electronics 1, Lec 29, Intro. to MOSFETs by Behzad Razavi (Long Kong) 235,680 views 9 years ago 1 hour, 4 minutes - Intro. to MOSFETs (for next series, search for Razavi Electronics 2 or longkong)

Structure of the Mosfet

Moore's Law

Voltage Dependent Current Source

Maus Structure

Mosfet Structure

Observations

Circuit Symbol

N Mosfet

Structure

Depletion Region

Threshold Voltage

So I Will Draw It like this Viji and because the Drain Voltage Is Constant I Will Denote It by a Battery
So Here's the Battery and Its Value Is Point Three Volts That's V_d and I'M Very Envious and I Would Like To See What Happens Now When I Say What Happens What Do I Exactly Mean What Am I Looking for What We'Re Looking for any Sort of Current That Flow Can Flow Anywhere Maybe See How those Currents Change Remember for a Diode We Applied a Voltage and Measure the Current as the Voltage Went from Let's Say Zero to 0.8 Volts We Saw that the Current Started from Zero Let's Look at the Current That Flows this Way this Way Here Remember in the Previous Structure When We Had a Voltage Difference between a and B and We Had some Electrons Here We Got a Current Going from this Side to this Side from a to B so a Same Thing the Same Thing Can Happen Here and that's the Current That Flows Here That Flows through this We Call this the Drain Current because It Goes through the Drain Terminal so We Will Denote this by I_d so this I_d and Then this Is I_d

And that's the Current That Flows Here That Flows through this We Call this the Drain Current because It Goes through the Drain Terminal so We Will Denote this by I_d so this I_d and Then this Is I_d this Is Called the Drain Current So I Would Like To Plot I_d as a Function of V_g V_d Constant 0.3 Volts We Don't Touch It We Just Change in V_g so What We Expect Use the G Here's I_d Okay Let's Start with V_g 0 Equal to 0 When V_g Is Equal to 0 this Voltage Is 0

So the Current through the Device Is Zero no Current Can Flow from Here to Here no Electrons Can Go from Here to Here no Positive Current Can Go from Here to Here so We Say an I_d Is Zero Alright so We Keep Increasing V_g and We Reach Threshold so What's the Region Threshold Voltage V_t H Then We Have Electrons Formed Here so We Have some Electrons and these Electrons Can Conduct Current so We Begin To See a Current Flowing this Way the Current Flowing this Way Starts from the Drain Goes through the Device through the Channel Goes to the Source Goes Back to Ground so We Begin To See some Current and as V_g Increases

Goes through the Device through the Channel Goes to the Source Goes Back to Ground so We Begin To See some Current and as V_g Increases this Current Increases Why because as V_g Increases the Resistance between the Source and Drain Decreases so if I Have a Constant Voltage Here if I Have a Constant Voltage Here and the Resistance between the Source and Drain Decreases this Current Has To Increase So this Current Increases Now We Don't Exactly Know in What Shape and Form Is the Linear and of the Net Cetera but At Least We Know It Has To Increase

Difference between the Gate and the Source between the Gate and the Source this Is Encouraging the Gate and the Source Okay Now Is There another Current Device That We Have To Worry about Well We Have a Current through the Source You Can Call It I_s and as You Can See the Drain Current at the Source Called Are Equal because if a Current Enters Here It Has Nowhere Else To Go so It Just Goes All the Way to the Source and Comes Out so the Drain Current the Source Current Are Equal so We Rarely Talk about the Source Current We Just Talk about the Drain

So We Don't Expect any Dc Current At Least To Flow through this Capacitor because We Know for Dc Currents Capacitors Are Open so to the First Order We Can Say that the Gate Current Is Zero Regardless of What's Going On around the Device so We Will Write that Here and We'll Just Remember that I_g Is Equal to Zero Now in Modern Devices That's Not Exactly True There's a Bit of Gate Current but in this Course We Don't Worry about It Okay Let's Go to Case Number Two in Case Number Two I Will Keep the Gate Voltage Constant

In Modern Devices That's Not Exactly True There's a Bit of Gate Current but in this Course We Don't Worry about It Okay Let's Go to Case Number Two in Case Number Two I Will Keep the Gate Voltage Constant and Reasonable What's Reasonable Maybe More than a Threshold To Keep the Device To Have a Channel so We Say V_g Is Constant Eg One Volt so We Want To Have a Channel of Electrons in the Device and Now We Vary the Drain Voltage So I Will Redraw the Circuit and I Put a Variable So We Say V_g Is Constant Eg One Volt so We Want To Have a Channel of Electrons in the Device and Now We Vary the Drain Voltage So I Will Redraw the Circuit and I Put a Variable Sorry I Put a Constant Voltage Source Here Battery So Here's the Battery of Value One Volt and Then I Apply a Variable Voltage to the Drain between the Drain and the Source Really So that's V_d and Again I Would Like To See What Happens and by that We Mean How Does the Current of the Device Change We Have Only Really a Drain Current so that's What We'Re GonNa Plot as a Function of V_d We Have Only Really a Drain Current so that's What We'Re GonNa Plot as a Function of V_d so the

Plot I_D as a Function of V_D Okay When V_D Is 0 How Much Current Do We Have Well if You Have Zero Voltage across a Resistor We Have Zero Current Doesn't Matter What the Resistor Is Right this One Can Be High or Low but You Have Zero Current So no Current Here but So Again in Your Mind You Can Place the Resistor

If You Have Zero Voltage across a Resistor We Have Zero Current Doesn't Matter What the Resistor Is Right this One Can Be High or Low but You Have Zero Current So no Current Here but So Again in Your Mind You Can Place the Resistor between these Two Points When the Channel Is on We Said It Looks like a Resistor Dried Is a Resistor between Source and Drain and as this Voltage Increases this Color Wants To Increase So this Current Begins To Increase Right Away There's no Constant Threshold on this Side Right because if the Gate Has a Sufficiently Positive Voltage on It There Is Already a Channel of Electrons Here and all We Need To Do Is Increase this Voltage To Increase that Current

Right Away There's no Constant Threshold on this Side Right because if the Gate Has a Sufficiently Positive Voltage on It There Is Already a Channel of Electrons Here and all We Need To Do Is Increase this Voltage To Increase that Current so We Get Something like that and Again We Don't Know Where It Goes Etc but that's the General Shape of It All Right so this Is Called the I_D V_D Characteristic this Is Called the I_D V_G Characteristic and They Are Distinctly Different and They Have Meet They Mean Different Things and We Always Play with these Characteristics for a Given Device To Understand these Properties

There Is Already a Channel of Electrons Here and all We Need To Do Is Increase this Voltage To Increase that Current so We Get Something like that and Again We Don't Know Where It Goes Etc but that's the General Shape of It All Right so this Is Called the I_D V_D Characteristic this Is Called the I_D V_G Characteristic and They Are Distinctly Different and They Have Meet They Mean Different Things and We Always Play with these Characteristics for a Given Device To Understand these Properties Alright Our Time Is up the Next Lecture We Will Pick Up from Here and Dive into the Physics of the Mass Device I Will See You Next Time

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Binary Numbers

The Buffer Gate

Not Gate

Or Circuit

Nand Gate

Truth Table

The Truth Table of a Nand Gate

The nor Gate

Nor Gate

Write a Function Given a Block Diagram

Challenge Problem

Or Gate

Sop Expression

Literals

Basic Rules of Boolean Algebra

Commutative Property

Associative Property

The Identity Rule

Null Property

Complements

And Gate

And Logic Gate

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