

BACK TO BASICS

BASICS OF FETS

INTRODUCTION TO FIELD EFFECT TRANSISTORS

TYPES

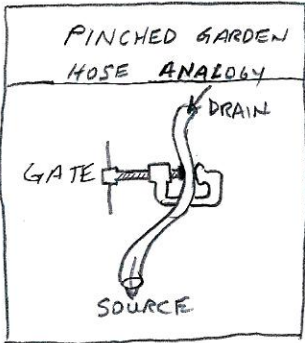
JFET
MOSFET

POLARITIES

N-CHANNEL
P-CHANNEL

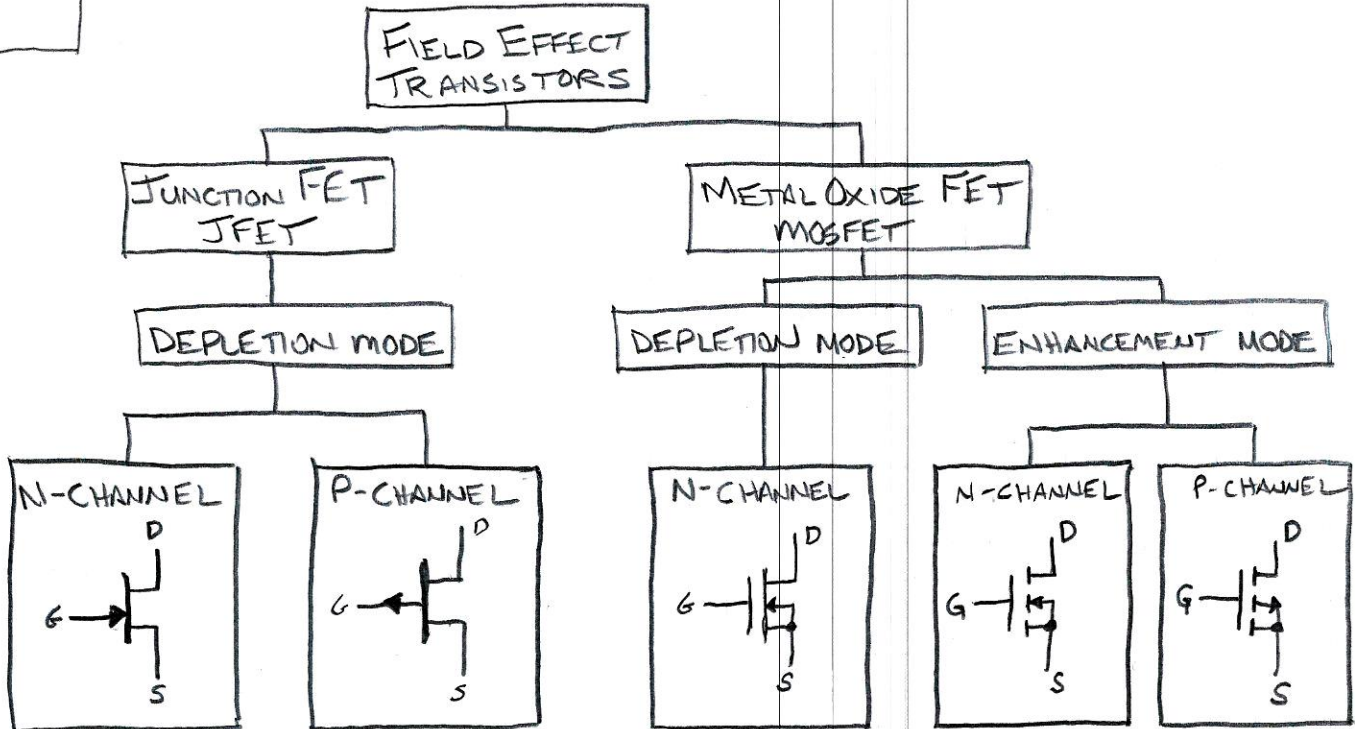
MODES

DEPLETION
ENHANCEMENT



FET FAMILY TREE

{ THE CHANNEL REFERS TO THE PATH BETWEEN THE DRAIN & SOURCE }



(NOT VERY COMMON)

KEY CHARACTERISTICS

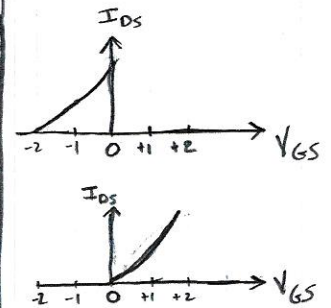
- GATE INPUT DRAWS NO CURRENT
EXTREMELY HIGH INPUT IMPEDANCE
- VERY EFFICIENT IN SWITCH APPLICATIONS

DEPLETION VS ENHANCEMENT MODE

- DEPLETION: CHANNEL FILLED WITH CARRIERS @ $V_{GS} = 0$, CONTROL VIA DEPLETING CARRIERS
- ENHANCEMENT: CHANNEL VOID OF CARRIERS @ $V_{GS} = 0$, CONTROL BY ENHANCING CHANNEL w/ CARRIERS

FOR
N-CHANNEL
DEVICES

		V_{GS} : GATE - SOURCE VOLTAGE		
		$V_{GS} < 0$	$V_{GS} = 0$	$V_{GS} > 0$
DEPLETION MODE		CHANNEL TURNS OFF	CHANNEL IS ON	
ENHANCEMENT MODE			CHANNEL IS OFF	CHANNEL TURNS ON

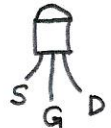


BE CAREFUL w/ PINOUTS!

N-CHANNEL VS. P-CHANNEL

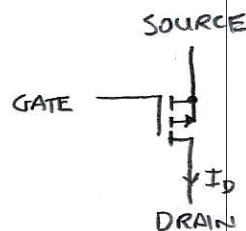
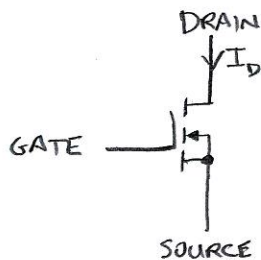
J310

2N7000



- FOR P-CHANNEL, ALL TERMINAL VOLTAGES AND CURRENTS ARE OPPOSITE POLARITY FROM N-CHANNEL

(SIMILAR TO PNP VS. NPN FOR BIPOLAR Q's)



N-CHANNEL

P-CHANNEL

$V_D > V_S$

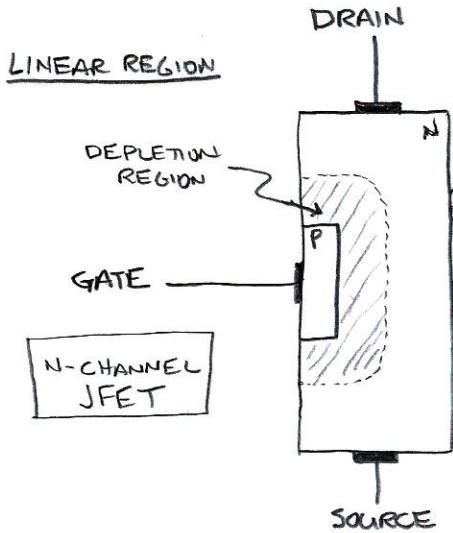
$V_D < V_S$

DRAIN "SINKS" I_D

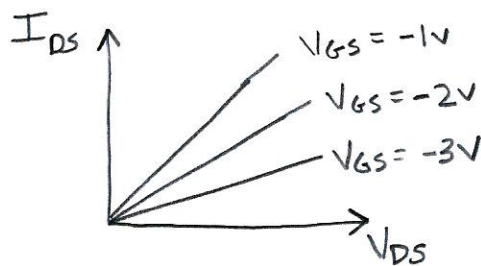
DRAIN "SOURCES" I_D

WE WILL MAINLY DISCUSS N-CHANNEL TODAY

JUNCTION FET



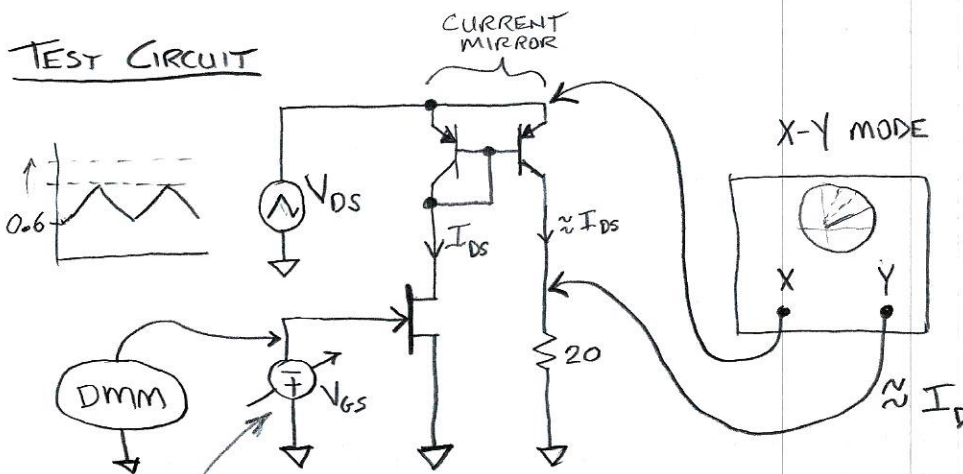
- GATE TO SOURCE (DRAIN) IS BASICALLY A DIODE
- NEVER FORWARD BIAS GATE - SOURCE
- WHEN $V_{GS} = 0$, CHANNEL IS THE MOST CONDUCTIVE (LEAST RESISTANCE)
- REVERSE BIASING GATE - SOURCE JUNCTION INCREASES DEPLETION REGION ...
- ... WHICH PINCHES THE CHANNEL, INCREASING THE RESISTANCE.



- THUS: THE DRAIN - TO - SOURCE RESISTANCE IS CONTROLLED BY THE GATE - SOURCE VOLTAGE V_{GS} DUE TO ELECTRIC FIELD CREATING A DEPLETION REGION.

- THIS IS THE LINEAR REGION OF OPERATION

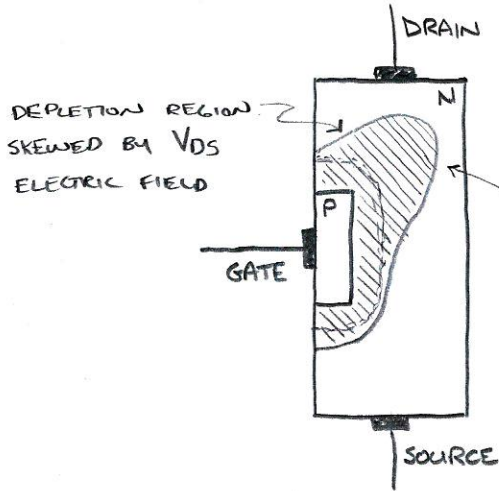
- VALID ONLY FOR LOW VALUES OF V_{DS}



REVERSE POLARITY FOR ENHANCEMENT MODE DEVICES

SATURATION REGION OF OPERATION

AT LARGER V_{DS} VOLTAGES

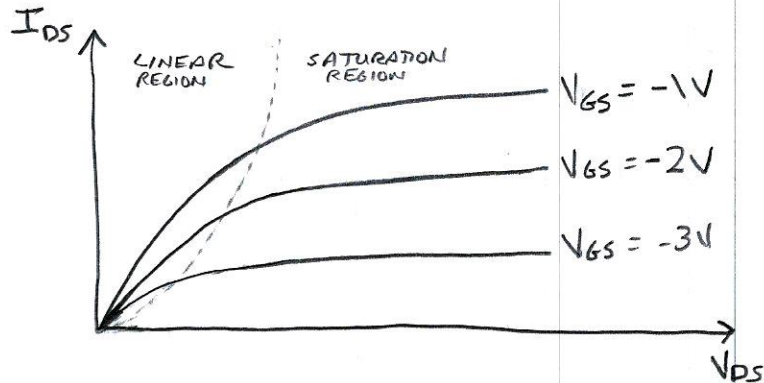


- AS V_{DS} INCREASES, THE ELECTRIC FIELD FROM DRAIN TO SOURCE SKEWS THE SHAPE OF THE DEPLETION REGION

- THIS PINCHES THE CHANNEL FURTHER, INCREASING THE RESISTANCE

- APPLICATIONS SUCH AS AMPLIFIERS, ETC ARE BIASED IN THE SATURATION REGION

- APPLICATIONS SUCH AS SWITCHES, VAR GAIN / ATTEN ARE BIASED IN THE LINEAR REGION

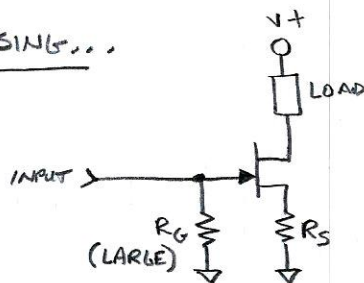


- WHEN $V_{GS} = 0$, DRAIN CURRENT MAX'S OUT AT I_{DSS} VALUE

- ALL JFETS ARE DEPLETION MODE DEVICES

- CHANNEL IS CONTROLLED BY DEPLETING THE CHANNEL OF CARRIERS,, EXPANDING / SHRINKING THE DEPLETION REGION

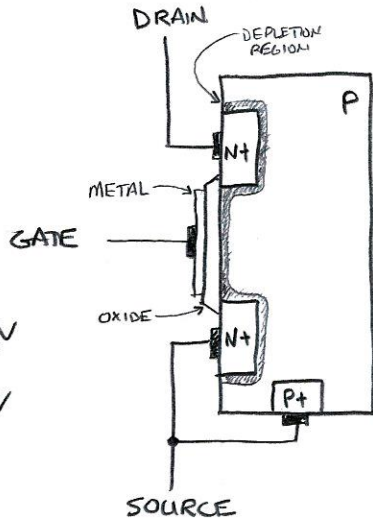
SIMPLE JFET BIASING...



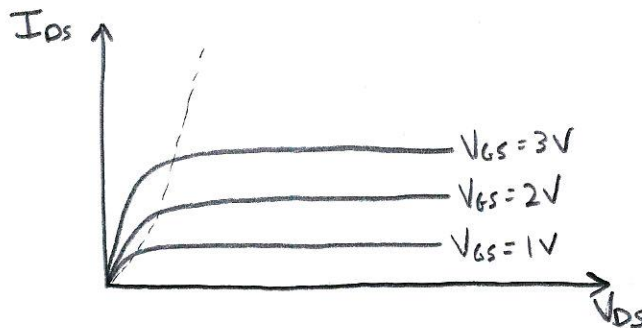
METAL OXIDE FET - MOSFET

ENHANCEMENT MODE

N-CHANNEL
DEVICE



- WHEN $V_{GS} = 0$, A DEPLETION LAYER IS FORMED, PREVENTING CURRENT FLOW FROM DRAIN TO SOURCE
- AS V_{GS} IS INCREASED (> 0), CARRIERS ARE DRAWN INTO THE CHANNEL BY THE V_{GS} ELECTRIC FIELD
- THIS INCREASES THE CONDUCTIVITY OF THE CHANNEL
- THE FIELD FROM THE DRAIN-SOURCE VOLTAGE SKEWS SHAPE OF THE CHANNEL
- THUS - MOSFET ALSO HAS LINEAR & SATURATION REGIONS OF OPERATION



- POWER MOSFETS OPTIMIZED FOR VERY LOW CHANNEL RESISTANCE: $R_{DS(on)}$
- DEPLETION MODE N-CHANNEL MOSFETS EXIST, BUT NOT COMMON (OPERATION SIMILAR TO JFETS)