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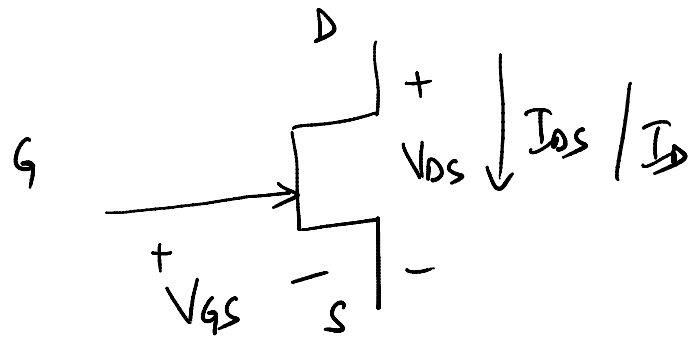
LECTURE-33

n-CHANNEL JFET → nFET



V_{DS} → DRAIN TO SOURCE VOLTAGE

I_{DS} → " " " CURRENT

V_{GS} → GATE TO SOURCE VOLTAGE

V_P → PINCH-OFF VOLTAGE → GATE-CHANNEL RB VOLTAGE FOR WHICH OPPOSITE DEPLETION REGIONS MERGE

(V_{P0})

I_{DSS} → DRAIN TO SOURCE SATURATION CURRENT (MAXIMUM CURRENT THAT FLOWS IN nFET WHEN THE DEVICE IS NORMALLY ON)

SPECIFIED AT $V_{GS} = 0V$

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3 REGIONS OF OPERATION

1. CUTOFF
2. SATURATION
3. TRIODE / NON SATURATION

TRANSISTOR IN SATURATION

$$I_{DS} = I_D = I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]^2$$

V_P NEGATIVE FOR nFET
POSITIVE FOR pFET

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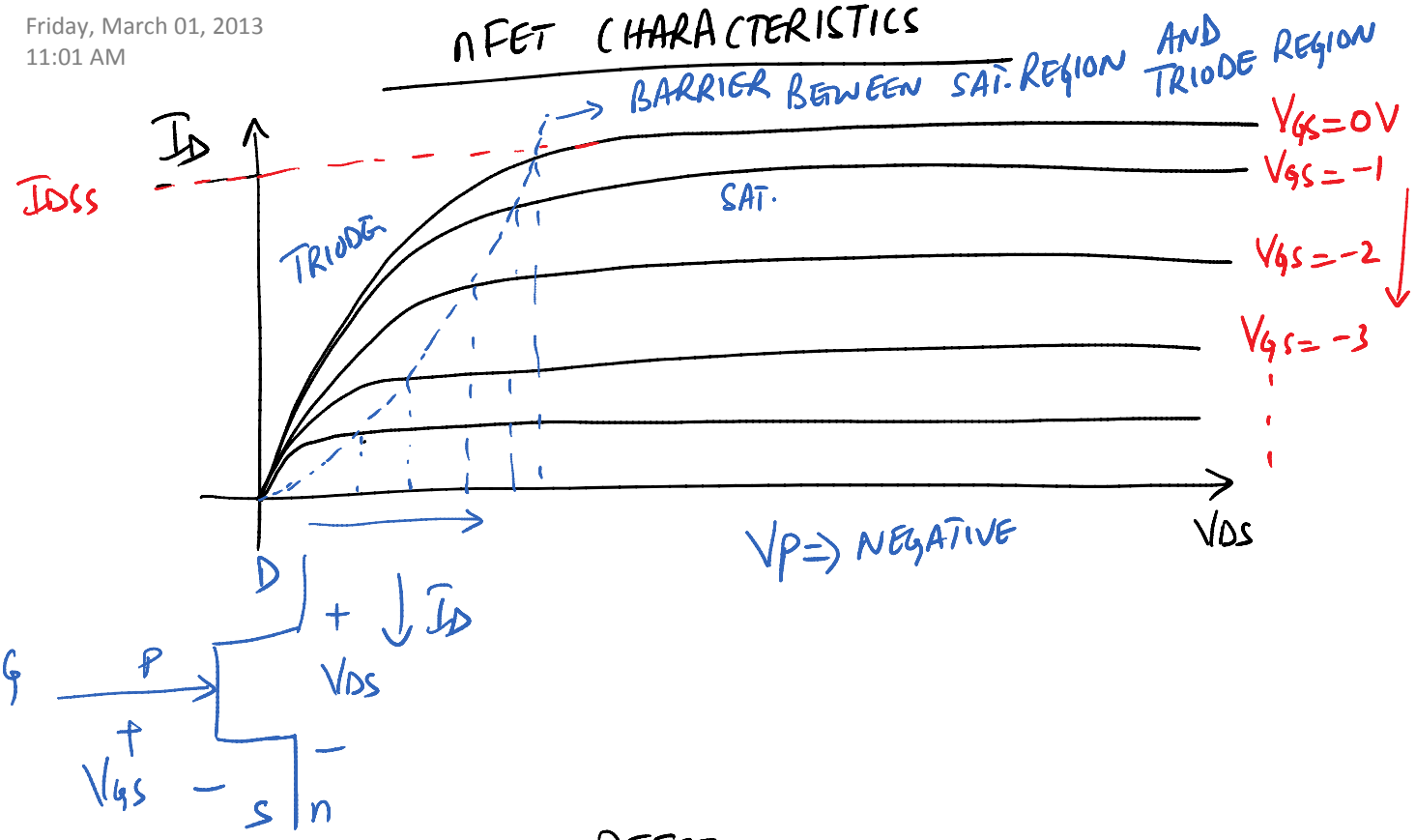
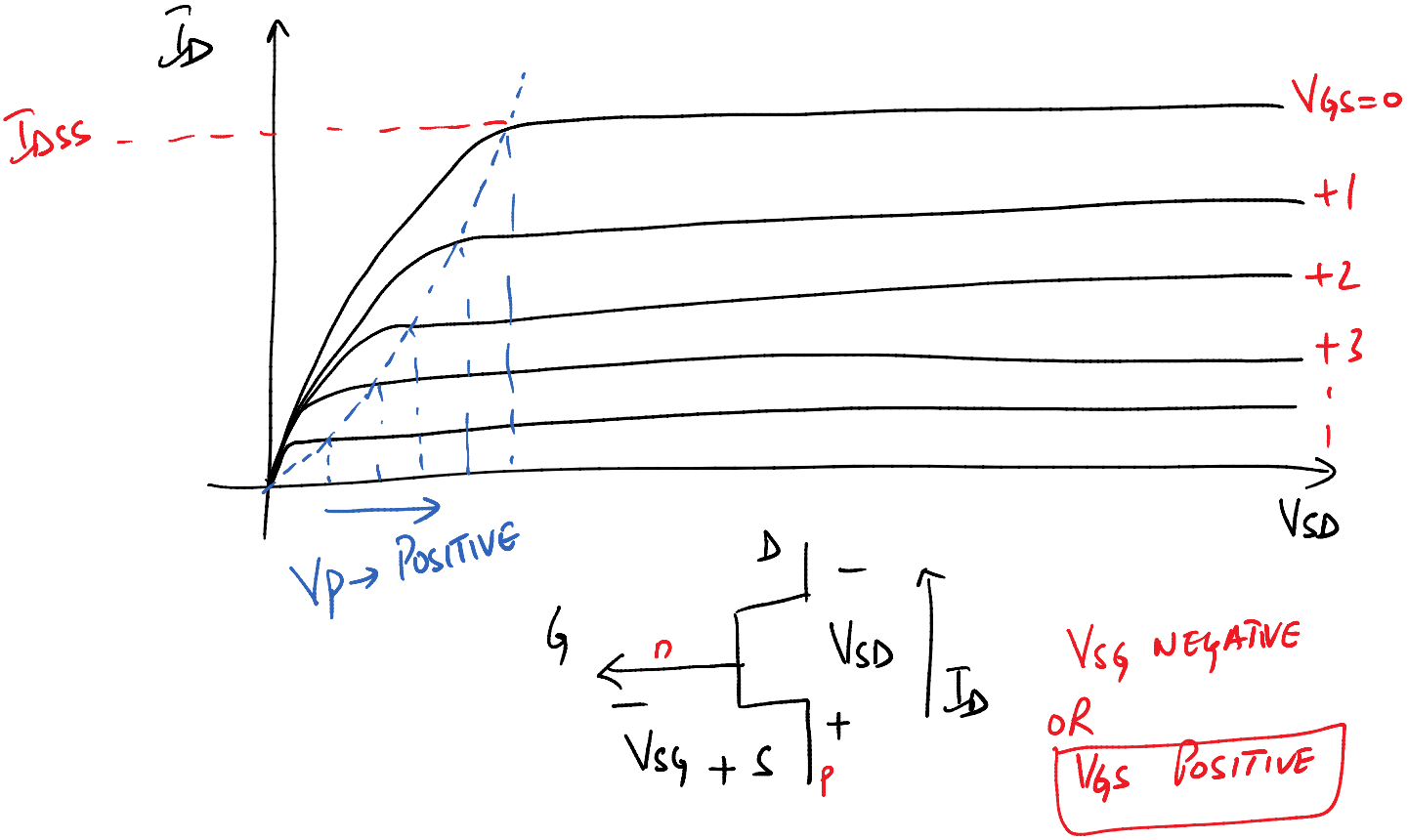
nFET CHARACTERISTICS



PJFET



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IN SAT.

$$I_D = I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]^2$$

NJFET

V_P IS NEGATIVE , V_{GS} NEGATIVE

$\therefore \frac{V_{GS}}{V_P}$ IS POSITIVE

PJFET

V_P IS POSITIVE

V_{GS} IS POSITIVE

$\therefore \frac{V_{GS}}{V_P} \Rightarrow$ POSITIVE

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nJFET

SATURATION OCCURS WHEN $V_{DS} \geq V_{DS(SAT)}$

$$V_{DS(SAT)} = V_{GS} - V_P$$

POSITIVE

PJFET

SATURATION OCCURS WHEN $V_{SD} \geq V_{SD(SAT)}$

$$V_{SD(SAT)} = V_P - V_{GS}$$

POSITIVE

n JFET IN SATURATION

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

$$V_{DS} \geq V_{DS(SAT)}$$

$$V_{DS(SAT)} = V_{GS} - V_P$$

$$\therefore V_{DS} \geq V_{GS} - V_P$$

TRIODE REGION

$V_{DS} = V_{GS} - V_P$ IS TRANSITION POINT

$V_{GS} = V_{DS} + V_P$ → THRESHOLD POINT

IN TRIODE REGION

$$I_D = I_{DSS}\left[2\left(1-\frac{V_{GS}}{V_P}\right)\left(\frac{V_{DS}}{-V_P}\right)-\left(\frac{V_{DS}}{V_P}\right)^2\right]$$

AT TRANSITION POINT

$V_{DS} = V_{GS} - V_P$

$$I_D = I_{DSS}\left[2\left(1-\frac{V_{GS}}{V_P}\right)\left(\frac{V_{GS}-V_P}{-V_P}\right)-\left(\frac{V_{GS}-V_P}{V_P}\right)^2\right]$$

$$= I_{DSS}\left[2\left(1-\frac{V_{GS}}{V_P}\right)\left(\frac{V_P-V_{GS}}{V_P}\right)-\left(\frac{V_{GS}}{V_P}-1\right)^2\right]$$

$$= I_{DSS}\left[2\left(1-\frac{V_{GS}}{V_P}\right)\left(1-\frac{V_{GS}}{V_P}\right)-\left(1-\frac{V_{GS}}{V_P}\right)^2\right]$$

$$= I_{DSS}\left[2\left(1-\frac{V_{GS}}{V_P}\right)^2-\left(1-\frac{V_{GS}}{V_P}\right)^2\right]$$

$$I_D = I_{DSS}\left[1-\frac{V_{GS}}{V_P}\right]^2 \rightarrow \text{SAT. REGION}$$

$$I_D = I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]^2 \longrightarrow \text{SAT. REGION}$$

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P-CHANNEL PJFET

$$I_D = I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]^2$$

$$V_{SD} \geq V_{SD(SAT)}$$

$$V_{SD(SAT)} = V_P - V_{GS}$$

$$V_{SD} \geq V_P - V_{GS} \longrightarrow \text{FOR SAT.}$$

IF $V_{SD} < V_P - V_{GS}$ $\longrightarrow$ THEN IN THE TRIODE REGION

$V_{SD} = V_P - V_{GS}$ $\longrightarrow$ TRANSITION POINT

$$I_D = I_{DSS}\left[2\left(1 - \frac{V_{GS}}{V_P}\right)\left(\frac{V_{SD}}{V_P}\right) - \left(\frac{V_{SD}}{V_P}\right)^2\right]$$

DERIVATION LEFT TO STUDENTS!

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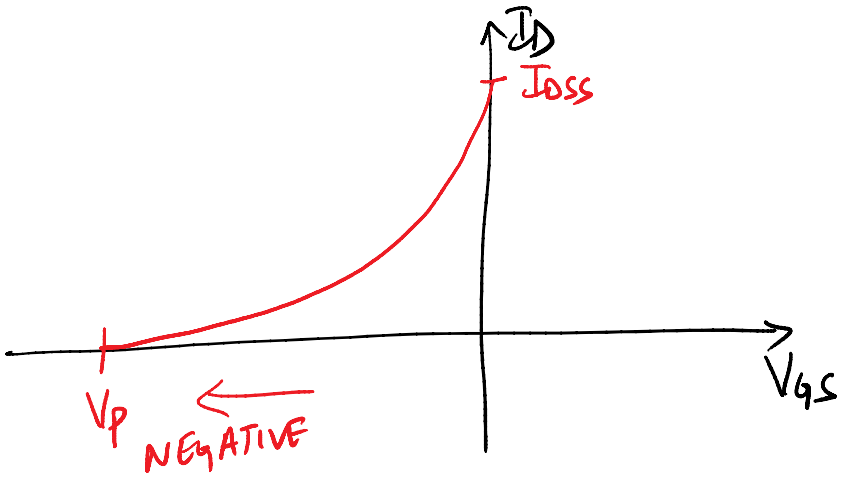
VOLTAGE TRANSFER CHARACTERISTICS



nJFET

pJFET