JFET (Part 1)

→ FET is fieldeffect transistor
→ FET is unipolar, the current flow between 2 terminals (Source & Drain) is controlled By Electric field applied to the third terminal (gate)
∴ Current is conducted only By majority charge carriers (holes / electron)

Advantages & disadvantages of JFET

Adv.

(1) FET is VCCS (Voltage Controlled Current Source), while Bjt is (CCCS) current Controlled Current Source)

(2) FET has large input impedance, So it is pereferred than Bjt as I/p stage to multistage amplifier

(3) FET generates lower noise level than Bjt.

(4) FET is more temperature stable than Bjt.

(5) FET is easier to be fabricated than Bjt.

(6) FET act as VCR (Voltage Controlled Resistor).

disAdv

1- FET has Poor frequency response (Low BW)
2- Poor linearity (non linear relation between I_D, V_{GS})
3. Due to static charge → Damage occured.

FET uses

Camera, Laptop, USB drive, Flash memory, CPU, --- etc.

(2)

metal oxide semi-cond. field effect tr.

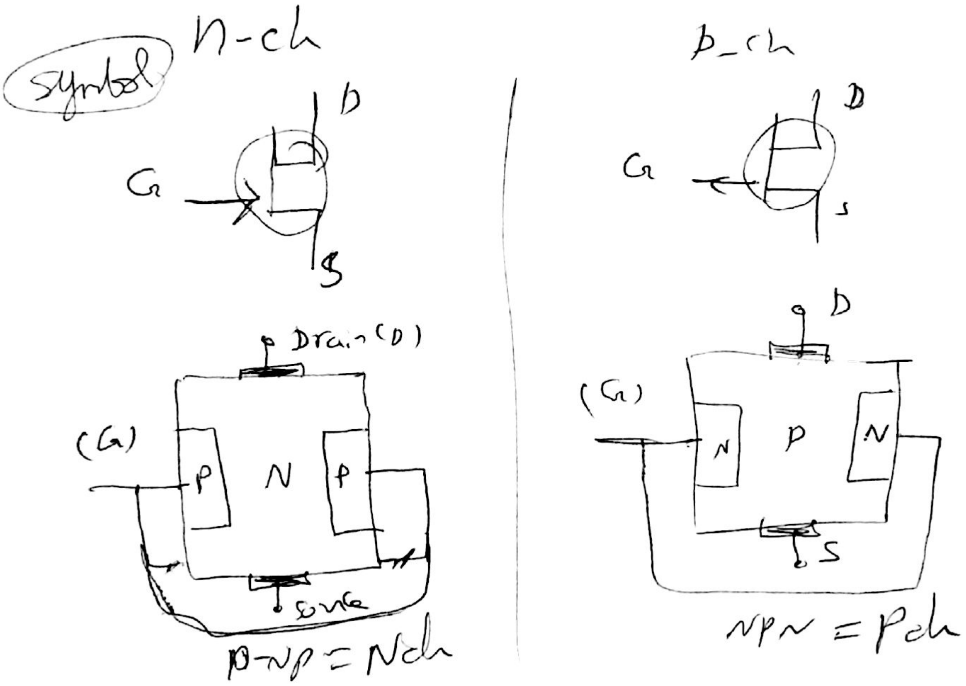
FET

- JFET (Junction field effect Trans.)
  - n-channel
  - p-channel
- Mosfet
  - Depletion
    - n-ch
    - p-ch
  - Enhanced
    - n-ch
    - p-ch
  - CMOS

(1) JFET

- n-ch → npn
- p-ch → pnp

3 terminal device



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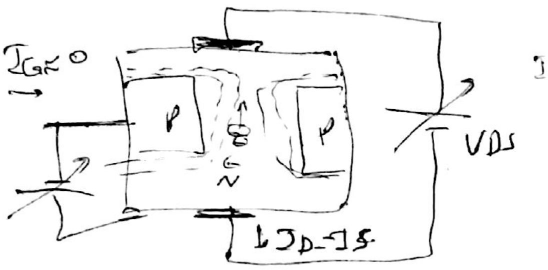
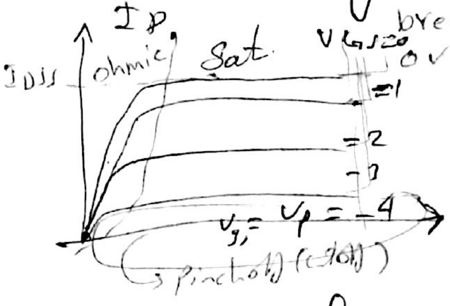
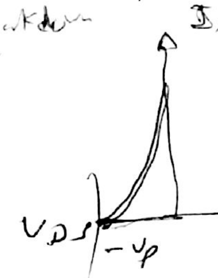
→ The N-channel Consists of N-type semiconductor & P-type on both side.

→ The channel is resistive Path, VDS drive a curren ID

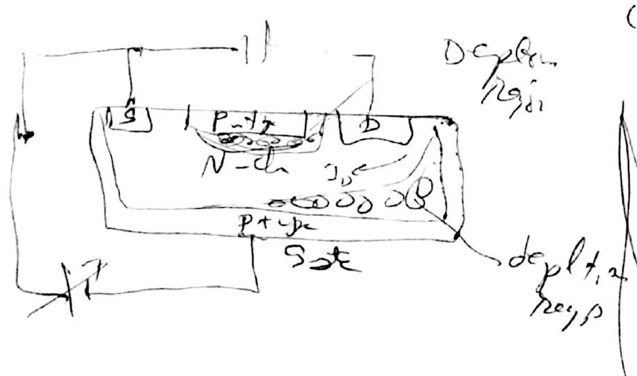
→ JFET has P-N junction (gate-to-channel) junction. & it is alway be (Reversie biased) in most applications. and hence only very small leakage Current will flow in gate terminal ⟹ Causing large input impedance.







← VGS يتحكم في عرض قناة channel (N)



① at VGS = 0

* as VDS ↑ increase, channel resistance (increase), because increase of ~~channel~~ depletion Region

حيث Vgs = 0 ... بزيادة VDS الـ ... القناة في الأول يزداد at

ثم الـ p-type تنجذب للـ ... وبالتالي حجم الـ depletion (الفقر) يزيد تدريجياً

زيادة VDS وتعمل ضغط على الـ channel لزيادة الـ depletion region الأمامية

معدل سريان ثابتاً ID = IDSS وعندها هذا الوصول VDS = -Vp

in case of Pinch off → ($V_{DS} = -V_p$, $V_{GS} = 0$ ∴ $I_D = I_{DSS}$)

الإلكترونات الـ P type تجذب الـ N من ناحية ... channel وتتحرك ...

VGS = صفر ... max

— وفي حالة VGS سالب ... تنجذب ... VGS ... P-type ...

... N-ch ... القناة channel الزيادة (depletion zone) ...

2- Increasing V_{GS} in (-ve) direction

ده دوس السالب

يجعل ال channel تضيق علشان في دوس $V_{GS}=0$ — وتقل السكر

لما تقل ال channel تقل المقاومة . هذه المنطقة التي تقل فيها depletion

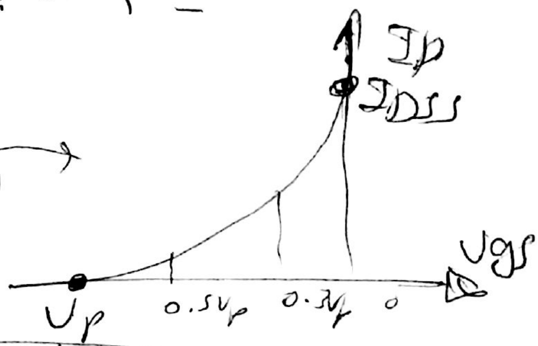
Region اللي تقابل ال channel كلها فاضية (channel is completely depleted of charge carriers)

ويكون لا يمر تيار وتسمى هذه الحالة (Pinchoff)

at $V_{GS} = -V_p$ | $I_D = 0$, V_{DS} is small

(shockly eqn) ويكون علينا القول بأن التيار I_D يعتمد على V_{GS}

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



note $I_G = 0$, $I_S = I_D$

مهم جداً لو وقف دوس الوس هيترم في fet في ...

Biasing of JFET

- fixed bias
- self bias (نفسه)
- Voltage divider Bias

1) Fixed Bias

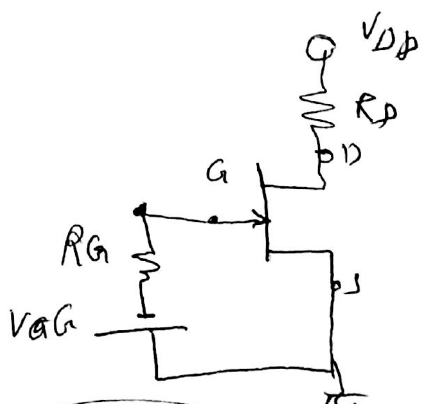
$I_G = 0$

$-V_{GG} - V_{GS} = I_G R_G$

$\therefore V_{GS} = -V_{GG}$

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

$V_{DS} = V_{DD} - I_D R_D$, $V_S = 0$, $V_D = V_{DS}$, $V_G = V_{GS}$



JFET , CS fixed Bias.

EX(1) $I_{DSS} = 10mA$, $V_p = -8V$, $R_G = 1M\Omega$
$R_D = 2k\Omega$, $V_{DD} = 20V$, $V_{GG} = 2V$, $V_{GS} =$

find V_{GSQ}, I_{DQ}, V_{DSQ}, V_D, V_S & V_G

Sol

$V_{GS} = -V_{GG} = -2V$

$I_{DQ} = I_{DSS}\left(1 - \frac{V_{GS}}{V_p}\right)^2 = 10\times10^{-3}\left(1 - \frac{-2}{-8}\right)^2 = 5.6mA$

$V_{DSQ} = V_{DD} - I_{DQ}R_D = 20 - 5.6\times10^{-3}\times2\times10^{3} = 8.75V$

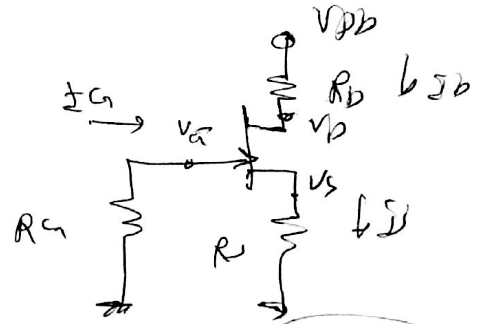
$V_D = V_{DS} = 8.75$

$V_S = 0$

$V_G = V_{GSQ} = -2V$

(الحل بايجاد الدائرة المكافئة أيضا فيها)

(Self Biasing)



$V_G = 0$

$V_S = I_S R_S$

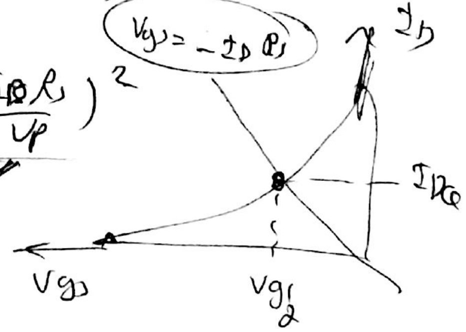
$V_{GS} = V_G - V_S = 0 - I_S R_S$

$V_{GS} = -I_S R_S = -I_D R_S$ → قيمة

$I_{DQ} = I_{DSS}\left(1 - \frac{V_{GS}}{V_p}\right)^2 = I_{DSS}\left(1 + \frac{I_D R_S}{V_p}\right)^2$

معادلة تربيعية

كل الرسم شرحها نوع I_D (V_{gs})



$V_{DS} = V_{DD} - I_D(R_D + R_S)$