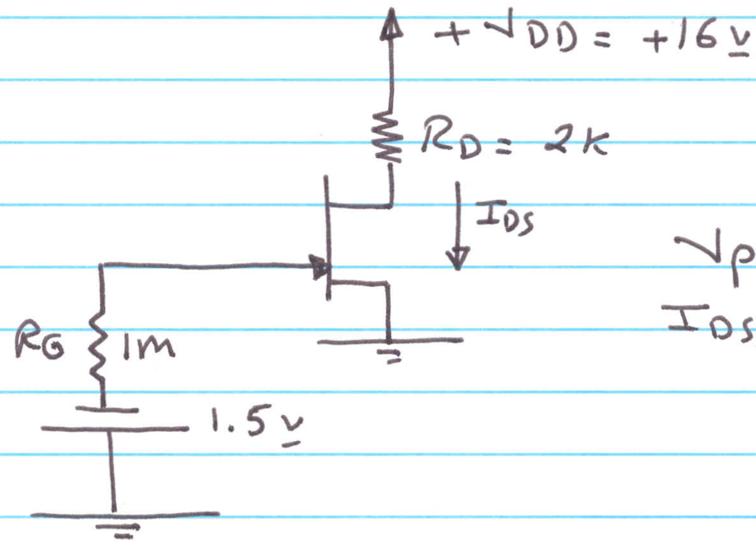
JFET Biasing Circuits

1) Fixed bias circuit



$V_p = -4\,v$

$I_{DSS} = 10\,mA$

Find Q point

Since $V_{GS} = -1.5\,v$, the JFET could be either in the ohmic or pinch off region.

assume that the JFET is in the pinch off region

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

$$V_{GS} = V_G - V_S = -1.5 - 0 = -1.5\,v$$

$$\therefore \quad I_{DS} = 3.9\ mA$$

$V_{DD} = R_D I_{DS} + V_{DS}$

$\therefore V_{DS} = 8.2 \ \underline{V}$

For the JFET to be in the pinch off region

$$|V_{DS}| > |V_p| - |V_{GS}|$$

$$> |-4| - |-1.5|$$

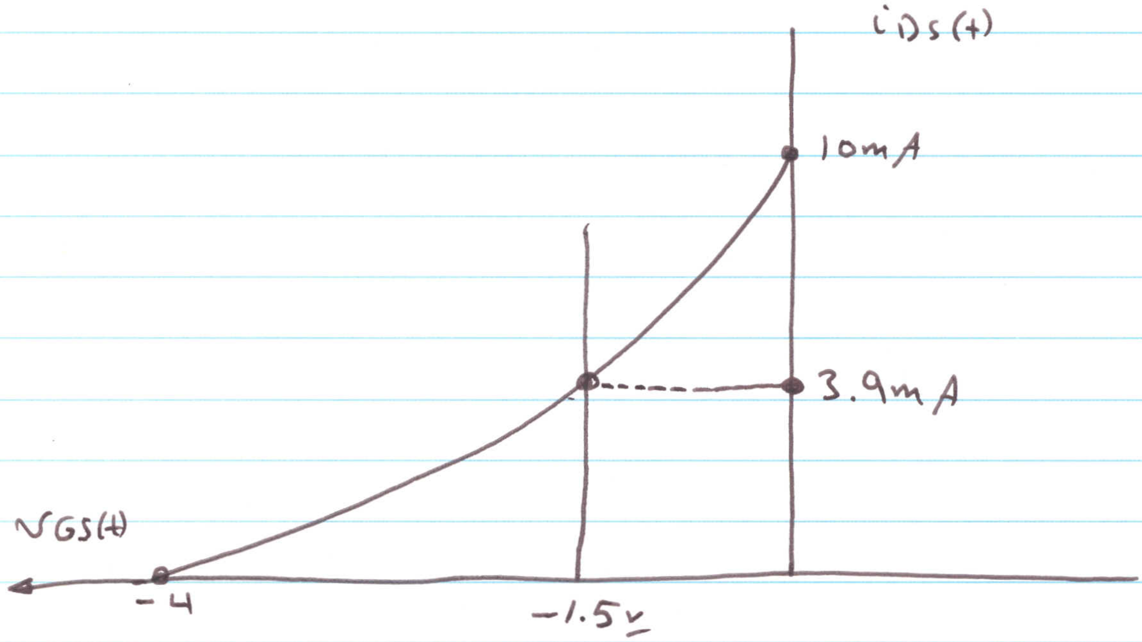
$$|V_{DS}| > 2.5$$

Since $V_{DS} > 2.5 \underline{V}$, $\therefore$ our assumption is OK

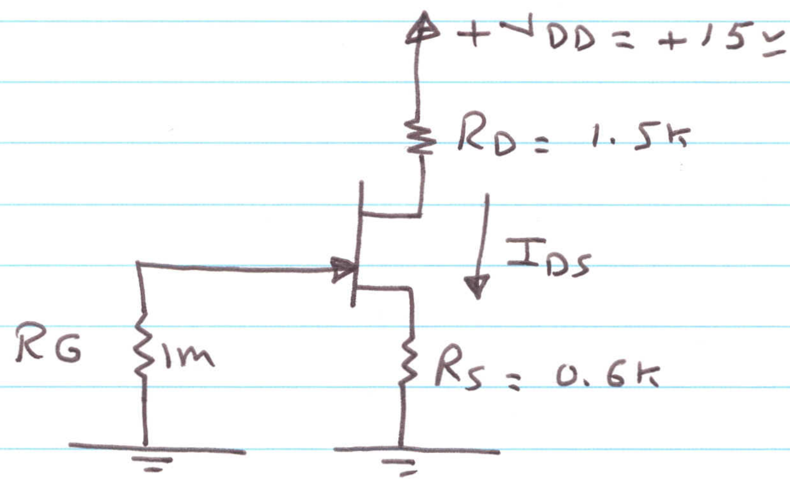
graphical method

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

$V_{GS} = -1.5v$



2) Self-bias Circuit



$V_p = -4V$

$I_{DSS} = 10mA$

assume that the JFET is in the pinch off region.

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

$$V_{GS} = V_G - V_S$$

$$V_{GS} = 0 - R_S I_{DS} = -R_S I_{DS} \quad -(2)$$

Sub (2) into (1)

$$I_{DS} = 10 \times 10^{-3}\left(1 - \frac{-0.6k\, I_{DS}}{-4}\right)^2$$

$\therefore\ I_{DS} = 14.77mA,\ 3mA$

Since $I_{DS} = 14.77mA > I_{DSS}$

$\therefore\ I_{DS} = 3mA$

$\therefore\ V_{GS} = -1.8V$

$$V_{DD} = R_D I_{DS} + V_{DS} + R_S I_{DS}$$

$\therefore \quad V_{DS} = 8.7\ \underline{v}$

For the JFET to be in the pinch off region

$$|V_{DS}| > |V_P| - |V_{GS}|$$

$$> |-4| - |-1.8|$$

$$|V_{DS}| > 2.2\ \underline{v}$$

$\therefore$ Since $|V_{DS}| > 2.2\ \underline{v}$, $\therefore$ the JFET is in the pinchoff region and our assumption is ok and

$$I_{DS} = 3.9\ mA$$

$$V_{DS} = 8.7\ \underline{v}$$

and $V_{GS} = -1.8\ \underline{v}$

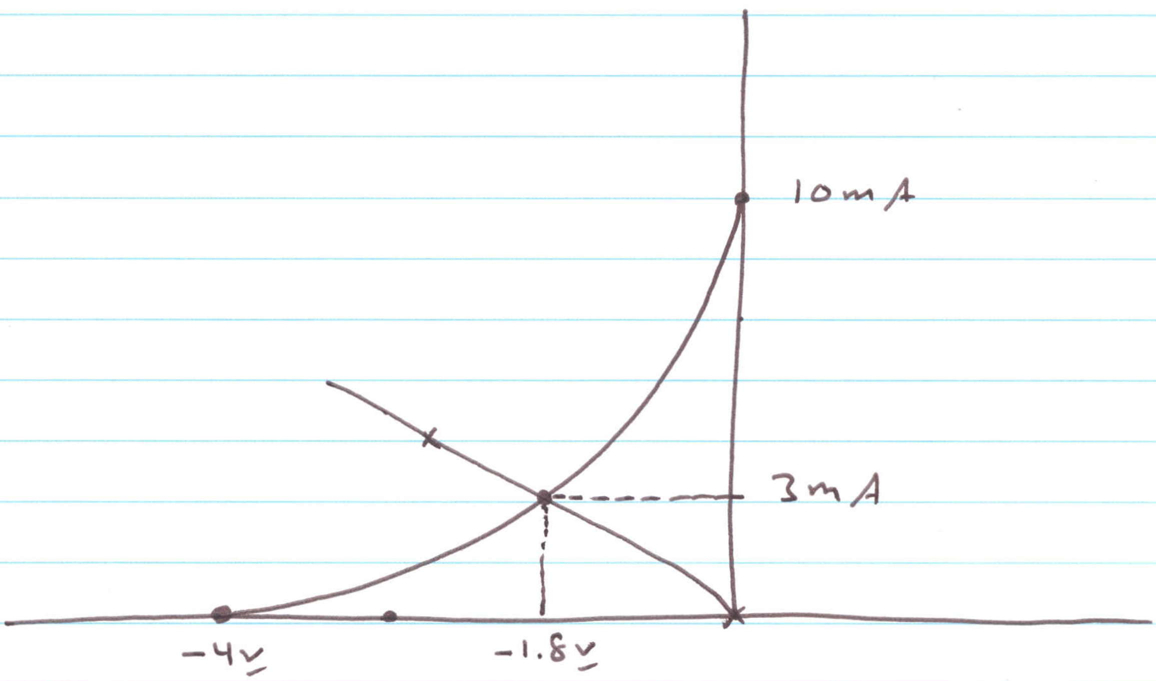
graphical method

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

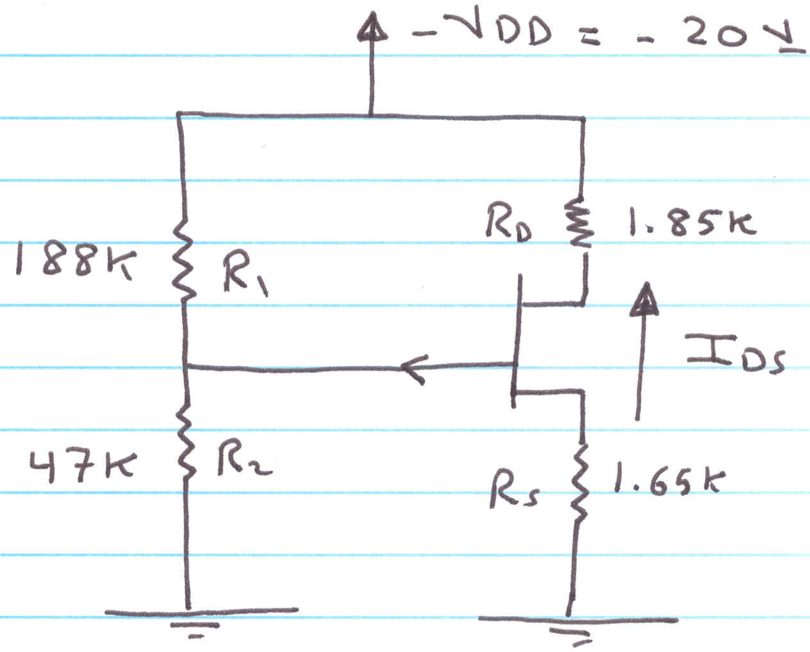
$$V_{GS} = -(0.6k)\, I_{DS}$$

when $V_{GS} = 0 \longrightarrow I_{DS} = 0\,mA$

when $V_{GS} = -3v \longrightarrow I_{DS} = 5\,mA$



3) Voltage Divider bias Circuit



$I_{DSS} = 18\,mA$

$V_p = +5\,V$

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

$V_{GS} = V_G - V_S$

$$V_G = \frac{47K}{47K + 188K}(-20) = -4\,V$$

$V_S = -R_S I_{DS} = -(1.65K) I_{DS}$

$$\therefore V_{GS} = -4 + (1.65K)(I_{DS}) \quad —②$$

Sub ② into ①, we obtain

$$I_{DS} = \begin{cases} 4.02\,mA & ✓ \\ 7.4\,mA & ✗ \end{cases}$$

$V_{DS} = -5.93\,V$

graphical method

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

$$V_{GS} = -4 + (1.65K)\, I_{DS}$$

when $V_{GS} = -4\,V$; $\longrightarrow$ $I_{DS} = 0$

when $V_{GS} = 0\,V$; $\longrightarrow$ $I_{DS} = 2.42\,mA$