JFET autobias	$R_S = \frac{V_{GS(off)}}{I_{DSS}}$
Gate source voltage	$V_{GS} \approx 0.4 \times V_{GS(off)}$
Drain current	$I_D \approx 0.4 \times I_{DSS}$
Common source gain	$A_V = -g_m \times R_D$

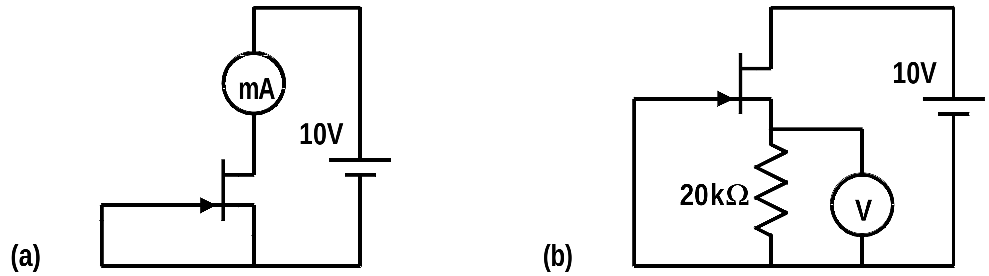
Typical gains about 10.

Typical input impedances about $1M\Omega$.

Only readily available parameters for a JFET such as the 2N3819, are I_{DSS}, $V_{GS(off)}$ and g_m

Characteristic curves may be available from the component manufacturer but with delays.

Average values for that JFET type number
Need a quick method of measuring the parameters for a particular JFET before using it.



Circuits to measure I_{DSS} and $V_{GS(off)}$ for a JFET

- (a) shows how the I_{DSS} can be measured directly

- (b) gives Gate-Source cut off voltage $V_{GS(off)}$

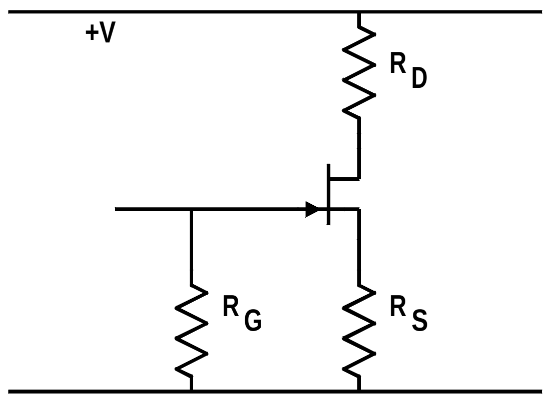
The equation for JFET drain current at any gate to source voltage is:–

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

Differentiate this to get:–

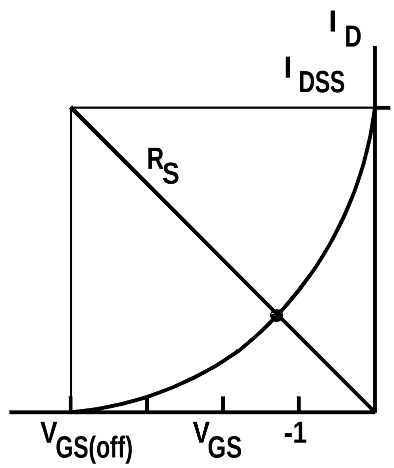
$$g_m = \frac{dI_D}{dV_{GS}} = -2\frac{I_{DSS}}{V_{GS(off)}}\left(1 - \frac{V_{GS}}{V_{GS(off)}}\right)$$

g_m is called mutual conductance
Note that g_m is positive since both V_{GS} and $V_{GS(off)}$ are negative quantities.



JFET amplifier autobias circuit

Source current through the JFET also flows through R_S to give a reverse bias of $I_D \times R_S$ between the gate and source.
The gate voltage is $0V$ because no significant current flows through R_G and through the reverse biased gate to channel junction.



Method of selecting R_S

Wide range of possible values for R_S

$$\text{Use} \quad R_S = \frac{V_{GS(off)}}{I_{DSS}}$$

Causes the bias point to be at the intersection of the line for R_S and the curve for V_{GS}

$$V_{GS} = I_D \times R_S = I_D \times \frac{V_{GS(off)}}{I_{DSS}}$$

$$\text{which gives } \frac{V_{GS}}{V_{GS(off)}} = \frac{I_D}{I_{DSS}}$$

Put into equation for I_D for the JFET

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

Gives an equation of the form $x = (1 - x)^2$ which has solutions $x \approx 2.6$ and $x \approx 0.4$.

$$\text{Use } \frac{V_{GS}}{V_{GS(off)}} = \frac{I_D}{I_{DSS}} = 0.4$$

$$\text{and then } I_D = 0.4 \times I_{DSS}$$

Select value for drain resistance, R_D.

The mutual conductance, g_m, relates the change in drain current to a change in the gate voltage:—

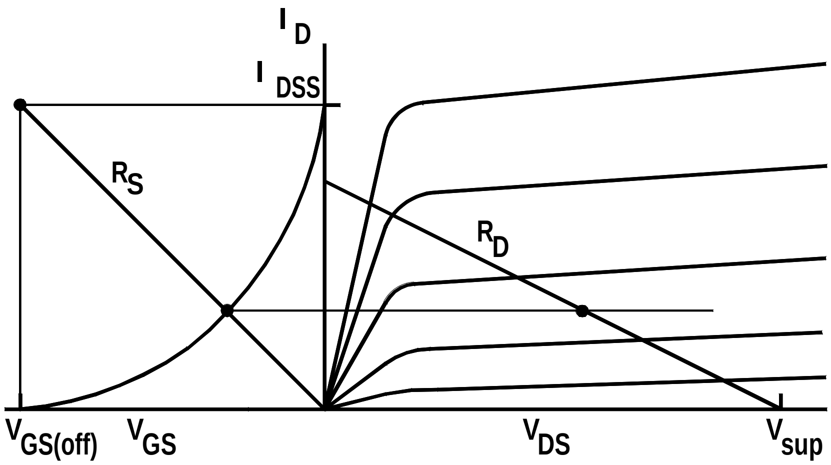
$$g_m = \frac{dI_D}{dV_{GS}} = \frac{i_d}{v_g}$$

The drain resistor relates the change in drain current to the change in the output voltage:—

$$v_d = -R_D \times i_d$$

Combine to get small signal voltage gain:—

$$A_V = \frac{v_{out}}{V_{in}} = \frac{v_d}{v_g} = \frac{-R_D \times i_d}{\frac{i_d}{g_m}} = -g_m R_D$$



If A_V, is specified then

$$R_D = \frac{A_V}{g_m}$$

Draw load line

Load line of slope R_D drawn through $2 \times 0.4 I_{DSS} = 0.8 I_{DSS}$ on the I_D axis

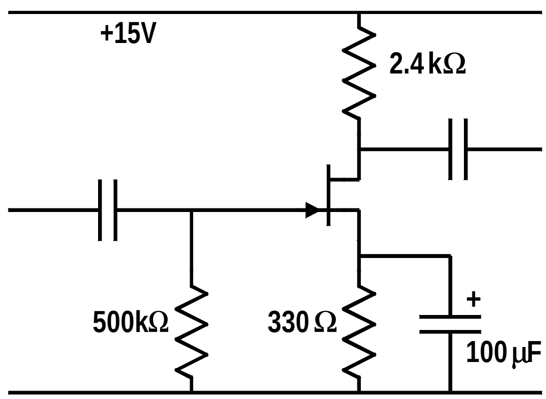
Select $V_{sup} = 0.8 \times I_{DSS} \times R_D$

$g_m \approx 2000\mu S$ and $R_D \approx 5k\Omega$

gains of the order of $g_m \times R_D = 10$ are expected

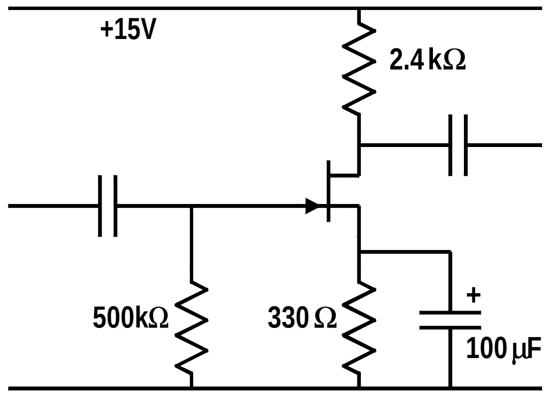
Gains are much lower than values of 200 for bipolar transistor amplifiers.

Input impedance is high



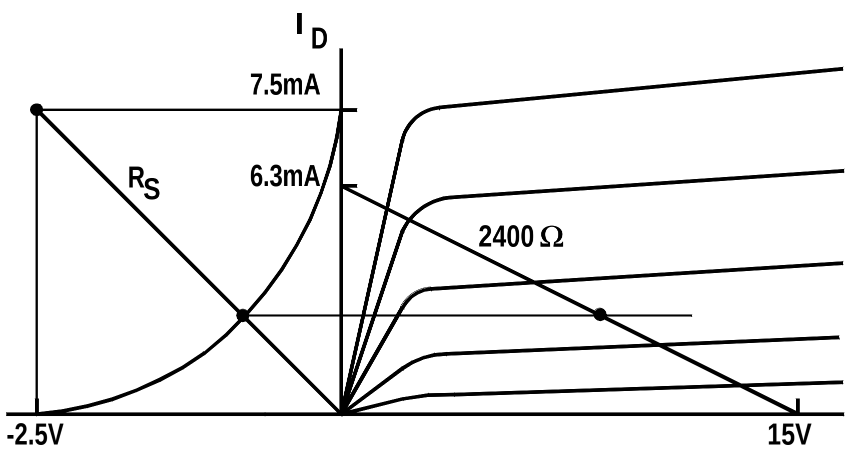
Calculate the component values and supply voltage to obtain a small signal voltage amplification, $A_V = -6$ and an input impedance of $500k\Omega$.

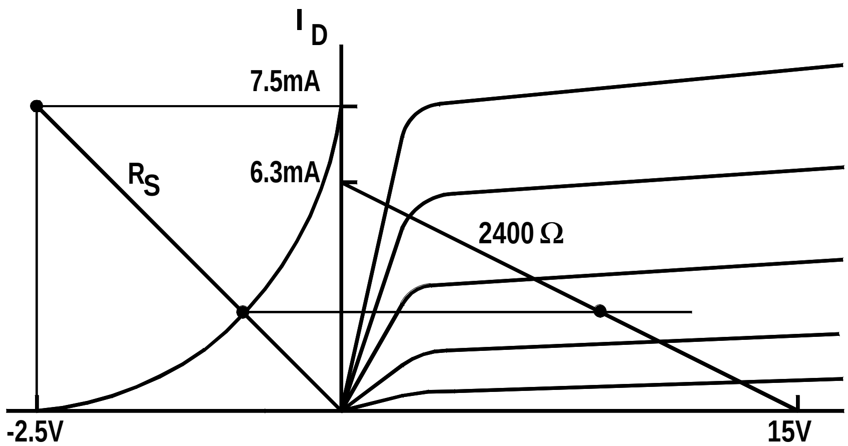
$g_m = 2500\mu S$, $V_{GS(off)} = 2.5V$ and $I_{DSS} = 7.5mA$.



$R_G = 500k\Omega$ gives required input impedance

$$\text{Let} R_S = \frac{V_{GS(off)}}{I_{DSS}} = \frac{2.5V}{7.5mA} = 330\Omega$$





gain of -6 therefore

$$A_V = -6 = -g_m \times R_D = -2500 \times 10^{-6} \times R_D$$

gives $R_D = \frac{6}{2500 \times 10^{-6}} = 2400\Omega = 2.4k\Omega$

It can be seen that a supply voltage of $15V$ gives a reasonable intersection point.