1 of 2. The figure shows a MOSFET signal circuit that is called a phase splitter. It is given that $R_D = R_S = 2\, \text{k}\Omega$, $g_m = 0.002 \, \text{S}$, and $r_0 = \infty$ (open circuit).

(a) Draw the Norton drain circuit and use it to solve for $v_{o1}$ as a function of $v_i$.

(b) Draw the Thévenin source circuit and use it to solve for $v_{o2}$ as a function of $v_i$.

(c) What might be the reason that the circuit is called a “phase splitter?”

\[ v_{o1} = -G_m v_i R_D = -\frac{R_D}{r_s + R_S} v_i = -0.8 v_i \]
\[ v_{o2} = \frac{R_S}{r_s + R_S} v_i = -0.8 v_i \]

The two outputs are 180° out of phase.

2 of 2. The figure shows a MOSFET bias circuit. Given: $V^+ = 24 \, \text{V}$, $R_D = 11 \, \text{k}\Omega$, $R_G = 100 \, \text{k}\Omega$, $R_S = 1.2 \, \text{k}\Omega$, $K = 10 \, \mu\text{S}/\text{V}^2$, and $V_{TO} = 1.8 \, \text{V}$.

(a) Solve for $V_{GG}$ and $R_{GG}$.
\[ V_{GG} = V^+ - I_D R_D \]
\[ R_{GG} = R_G + R_D \]

(b) Write the loop equation for the gate-source loop and use it to solve for $I_D$ assuming the MOSFET is in its saturation state.
\[ V^+ - I_D R_D = \sqrt{\frac{I_D}{K}} + V_{TO} + I_D R_S \implies I_D (R_D + R_S) + \frac{1}{\sqrt{K}} \sqrt{I_D} + (V_{TO} - V^+) = 0 \implies I_D = 1 \, \text{mA} \]

(b) For the value of $I_D$, check to verify that $V_{DS} > V_{GS} - V_{TO}$ for the MOSFET to be in the saturation state.

\[ V_{DS} = (V^+ - I_D R_D) - (I_D R_S) = 11.8 \, \text{V} \]
\[ V_{GS} - V_{TO} = \sqrt{\frac{I_D}{K}} = 10 \, \text{V} \]