

8.11

The Thevenin equivalent circuit for the biasing chain of R_1 and R_2 is a 3 V voltage source in series with a 75 k Ω source resistor.

a.) KVL yields: $12 = 2Ri_D + V_{DS} = 2Ri_D + 6 \Rightarrow Ri_D = 3$

Also: $3 = V_{GS} + Ri_D = V_{GS} + 3 \Rightarrow V_{GS} = 0$

b.) Since $V_{DS} = 6 > V_{GS} - V_p = 4$ the JFET is in the active region: $V_{GS} = 0 \rightarrow i_D = I_{DSS} = 12 \text{ mA}$

c.) $Ri_D = 3 \Rightarrow R = 3/i_D = 250\Omega$

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Assume active region; the upper JFET has index 1, the lower index 2:

a.) $V_{GS2} = 0 \Rightarrow i_{D2} = i_{D1} = i_D = I_{DSS} = 4 \text{ mA}$

b.) $i_{D1} = I_{DSS} \rightarrow V_{GS1} = 0$

c.) $10 = V_{DS1} - V_{GS1} = V_{DS1} - 0 = V_{DS1} \Rightarrow V_{D2} = 0 \Rightarrow V_{DS2} = 10 \text{ V}$

d.) $10 = V_{DS} > V_{GS} - V_p = 2$ for both JFETs; active region okay.

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Depletion MOSFETs are like JFETs, with the exception that you can go into the regime of gate voltages where you would forward bias the gate junction in the JFET (which is not allowed for the JFET). So for depletion MOSFETs we use the JFET equations; assuming active region operation:

a.) $(2 - V_{GS})/250 = i_D = 8m(1 + V_{GS}/2)^2 \Rightarrow V_{GS}^2 + 6V_{GS} = 0 = V_{GS}(V_{GS} + 6) = 0 \Rightarrow V_{GS} = 0$ since $-6 < V_p$.

b.) $V_{GS} = 0 \Rightarrow i_D = I_{DSS} = 8 \text{ mA}$

c.) $V_{DS} = 16 - 2Ri_D = 12 \text{ V}$

d.) $V_{DS} = 12 > V_{GS} - V_p = 2$

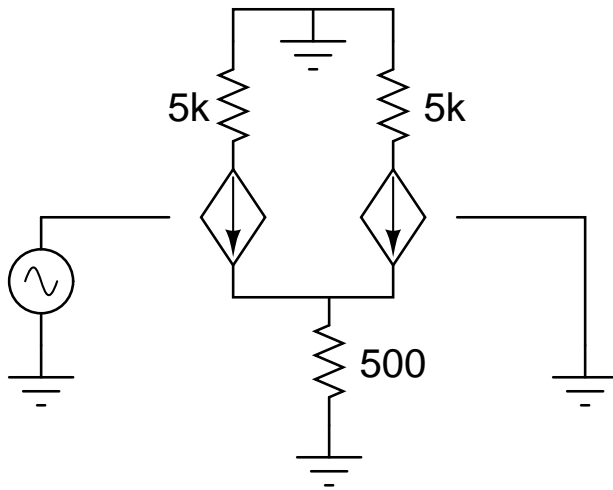
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M2 on border and $V_{GS} = 0 \Rightarrow i_D = I_{DSS2} = 16 \text{ mA}$

M1 in active region: $i_D = I_{DSS1}(1 - V_{GS1}/V_{p1})^2 = 16m = 8m(1 - V_{GG}/4)^2 \Rightarrow V_{GG} = 1.66 \text{ V}$

10.10

The mention of g_m indicates that we will be interested in the small-signal ac-equivalent circuit:

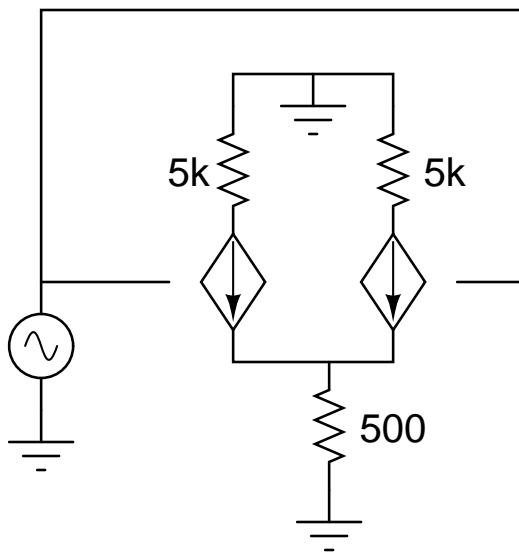


$$\text{KCL at } v_s: 2mv_{gs1} + 2mv_{gs2} = v_s/500 = 2m(v_1 - v_s) + 2m(0 - v_s) \Rightarrow v_s = v_1/3$$

$$\text{and } v_{d2} = -5k(2mv_{gs2}) = -5k2m(0 - v_s) = 10v_s$$

$$\Rightarrow v_{d2}/v_1 = 10/3$$

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$$\text{KCL at } v_s: 2mv_{gs1} + 2mv_{gs2} = v_s/500 = 2m(v_{cm} - v_s) + 2m(v_{cm} - v_s) \Rightarrow v_s = 2v_{cm}/3$$

$$\text{and } v_{d2} = -5k(2mv_{gs2}) = -5k2m(v_{cm} - v_s) = -10(v_{cm} - v_s)$$

$$\Rightarrow v_{d2}/v_{cm} = -10/3$$