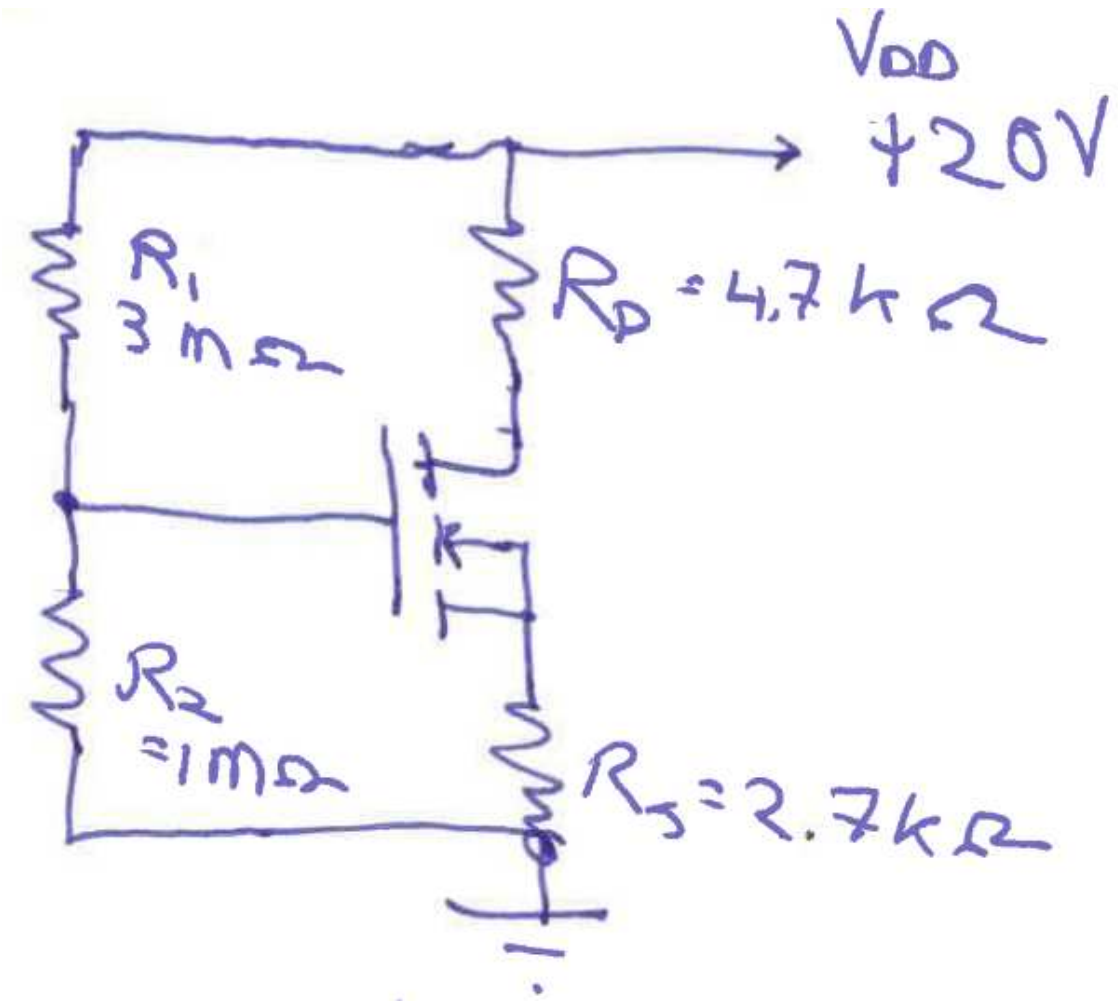
Fundamentals of Electronics
Week 10 Addendum

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DC FET Solutions (1)



Remember:

$k'_n = \mu_n C_{ox}$

NFET Parameters:

$k'_n = 50\mu\text{A/V}^2$,

$W = 400\mu\text{m}$,

$L = 10\mu\text{m}$,

$V_T = 2\text{V}$.

DC FET Solutions (2)

Starting Point

$$K = \frac{W}{L}\frac{k_n'}{2} = 1\text{mA/V}^2$$

$$I_G = 0$$

$$I_S = I_G$$

Thévenin Gate Circuit

$$V_G = V_{DD}\frac{R_2}{R_1 + R_2} = 5\text{V}$$

$$R_G = R_1 \parallel R_2 = 750\text{k}\Omega$$

DC FET Solutions (3)

Need to Solve for V_{GS}

$$V_G = V_{GS} + I_S R_S = V_{GS} + I_D R_S$$

Saturation

$$I_D = \mu_n C_{ox} \frac{W}{L} \frac{(V_{GS} - V_T)^2}{2} = K (V_{GS} - V_T)^2$$

Combine

$$V_G = V_{GS} + K (V_{GS} - V_T)^2 R_S$$

Quadratic

$$V_G = V_{GS} + K \left(V_{GS}^2 - 2 V_{GS} V_T + V_T^2 \right) R_S$$

DC FET Solutions (4)

$$V_G = V_{GS} + K\left(V_{GS}^2 - 2V_{GS}V_T + V_T^2\right)R_S$$

Group Like Powers of V_{GS}

$$V_G = V_{GS} + KV_{GS}^2R_s - 2KV_{GS}V_TR_S + KV_T^2R_S$$

$$KV_{GS}^2R_s + V_{GS} - 2KV_{GS}V_TR_S + KV_T^2R_S - V_G = 0$$

$$KV_{GS}^2R_s + (1 - 2KV_TR_S)\,V_{GS} + \left(KV_T^2R_S - V_G\right) = 0$$

$$aV_{GS}^2 + bV_{GS} + c = 0$$

$$a = kR_S \qquad b = (1 - 2KV_TR_S) \qquad c = KV_T^2R_S - V_G$$

DC FET Solutions (5)

$$aV_{GS}^2 + bV_{GS} + c = 0$$

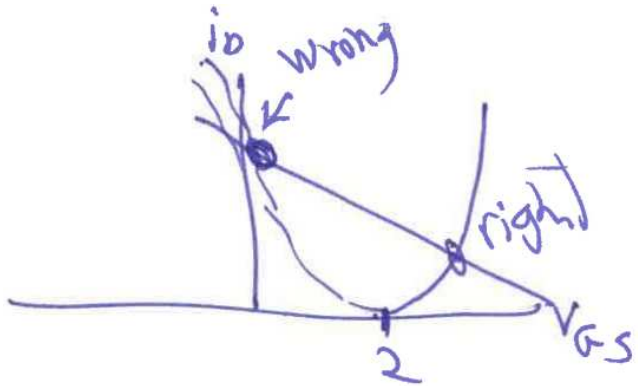
$$a = kR_S \qquad b = (1 - 2KV_TR_S) \qquad c = KV_T^2R_S - V_G$$

Compute the Numbers and Check the Units

$$a = 2.7\text{V}^{-1} \qquad b = -9.8 \text{ Unitless} \qquad c = 5.8\text{V}$$

Solve the Quadratic Equation

$$V_{GS} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = [0.744, 2.886]\text{V}$$



DC FET Solutions (6)

Finish the Calculations

$$I_D = K\,(V_{GS} - V_T)^2 = 785\mu\text{A}$$

$$V_D = V_{DD} - I_D R_D = 16.3\text{V}$$

