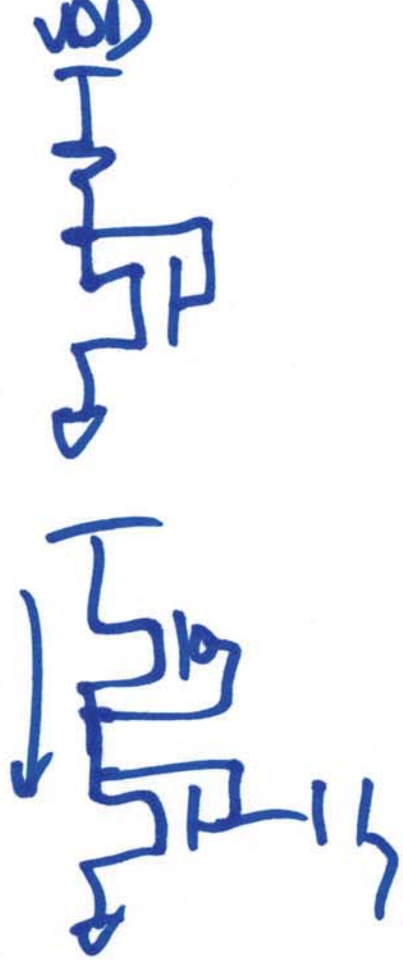
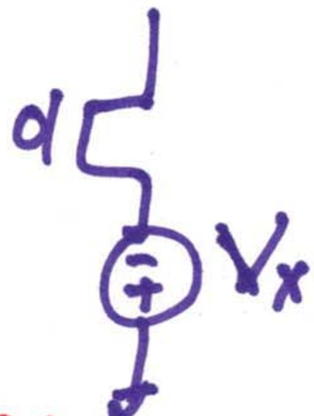
EE 420 / EGG 620

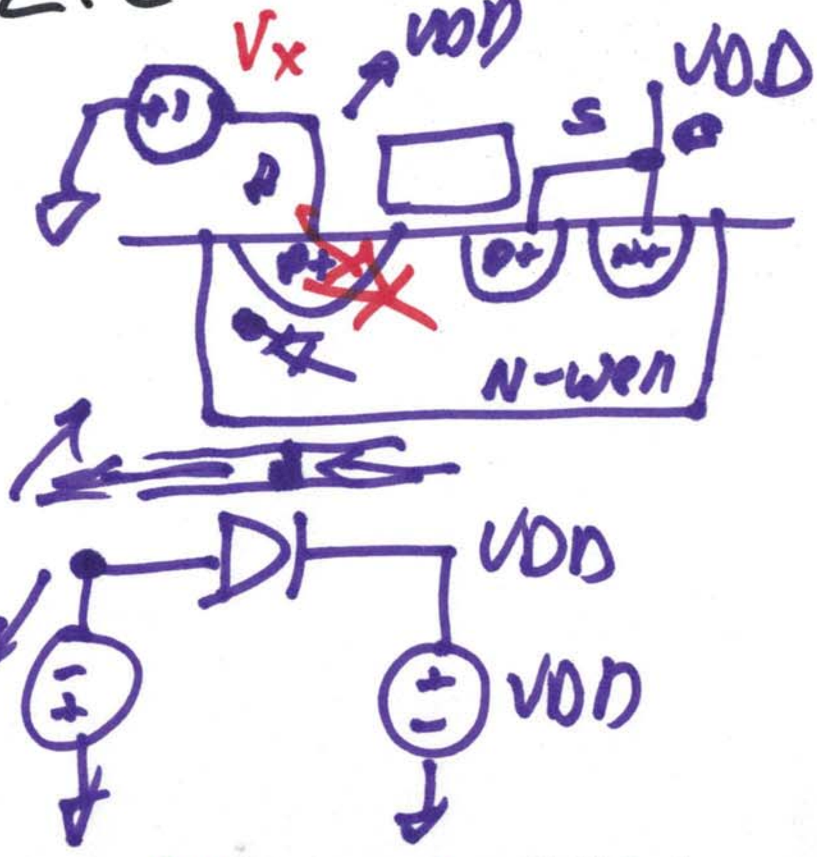
Analog IC Design

Feb. 19, 2016

Lecture 10



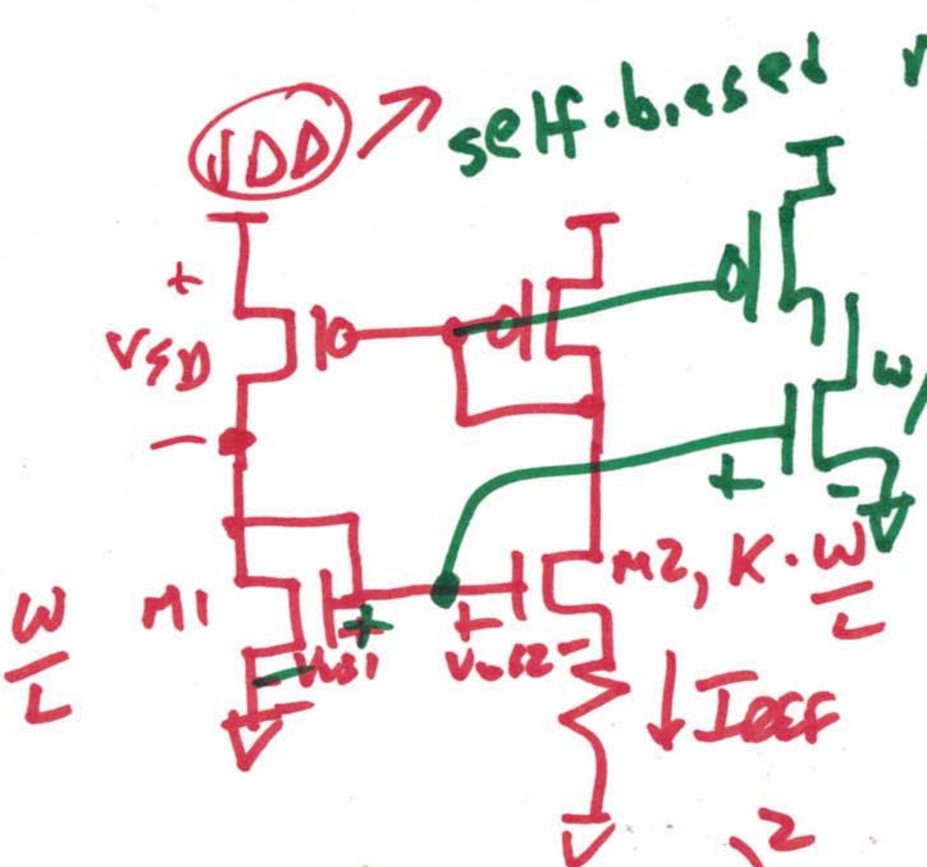




$V_{DD} = V_{SG} + V_{OS}$

Beta-Multiplier

Site: edu



$$V_{GS1} = V_{GS2} + I_{REF}\cdot R$$

$$\overbrace{\sqrt{\frac{2I_{REF}}{\beta_N}} + \cancel{V_{THN}}}^{V_{GS1}} = \underbrace{\sqrt{\frac{2I_{REF}}{K\cdot\beta_N}} + \cancel{V_{THN}}}_{V_{GS2}} + I_{REF}R$$

$$I_{REF} = \frac{\beta_N}{2}\left(V_{GS1} - V_{THN}\right)^2$$

$$I_{REF} = K\cdot\frac{\beta_N}{2}\left(V_{GS2} - V_{THN}\right)^2,$$

$$\sqrt{\frac{2}{\beta_N}} = \sqrt{\frac{2}{K\cdot\beta_N}} + \sqrt{I_{REF}}\cdot R$$

$$\sqrt{\frac{2}{R^2\cdot\beta_N}} = \sqrt{\frac{2}{K\cdot\beta_N R^2}} + \sqrt{I_{REF}}$$

$$\sqrt{I_{REF}} = \sqrt{\frac{2}{R^2\beta_N}} - \sqrt{\frac{2}{K\cdot\beta_N R^2}}$$

$$\beta_N = KP_n \cdot \frac{W}{L} = \mu_n \cdot C'_{ox} \cdot W/L$$

$$\sqrt{I_{REF}} = \sqrt{\frac{2}{R^2\beta_N}}\left(1 - \frac{1}{\sqrt{K}}\right)$$

$$\boxed{I_{REF} = \frac{2}{R^2\cdot\beta_N}\left(1 - \frac{1}{\sqrt{K}}\right)^2}$$

$$KP_N = \mu_n \cdot C'_{ox}$$

$$g_m = \frac{1}{R} \quad K = ?$$

$$K = 4$$

$$I_{REF} = \frac{1}{R^2\cdot 2\cdot\beta_N}$$

$$2 I_{REF}\cdot\beta_N = \frac{1}{R^2}$$

$$g_m = \sqrt{2 I_{REF}\cdot\beta_N} = \frac{1}{R}$$

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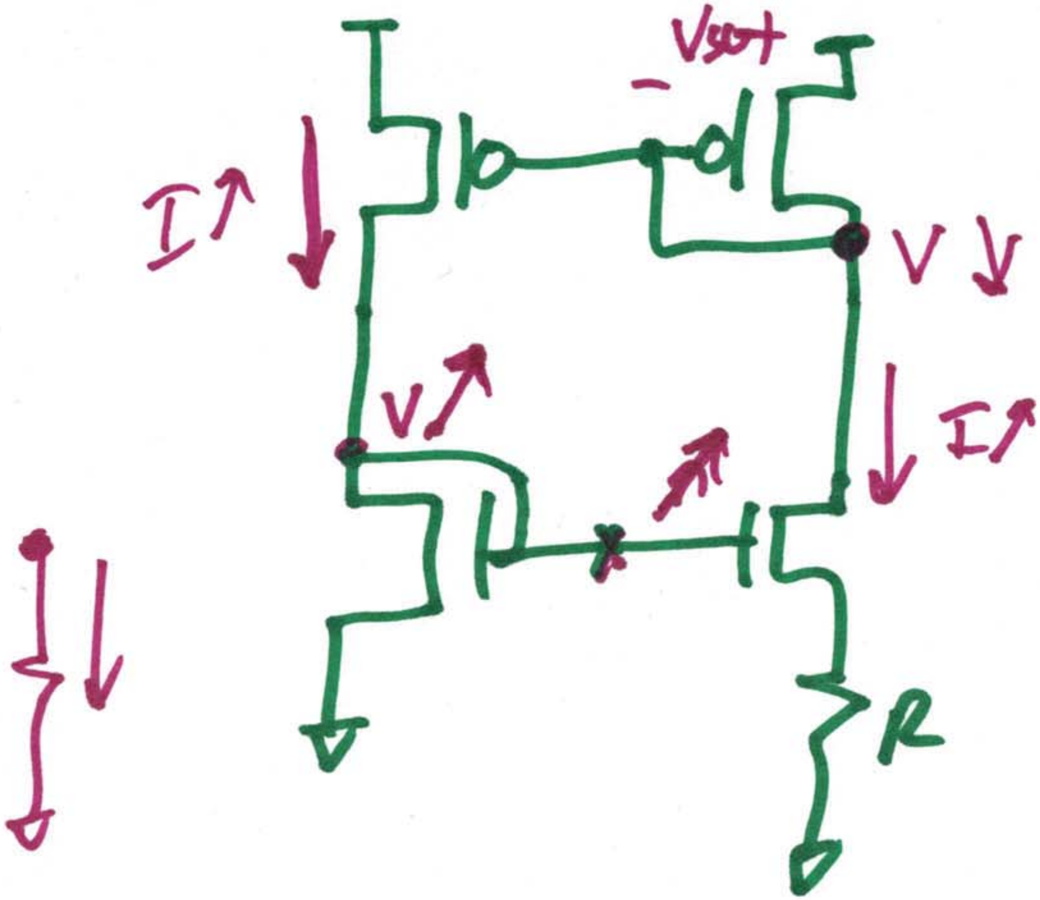
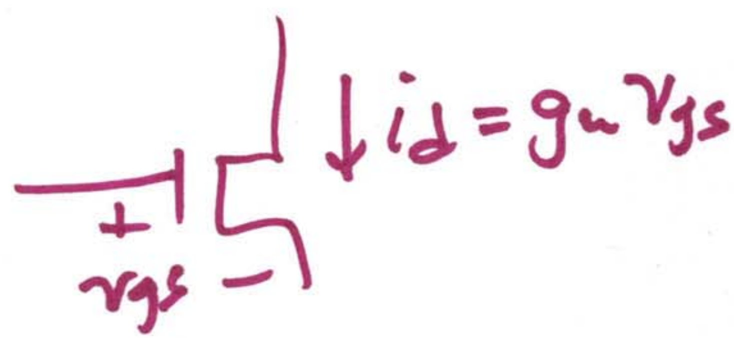
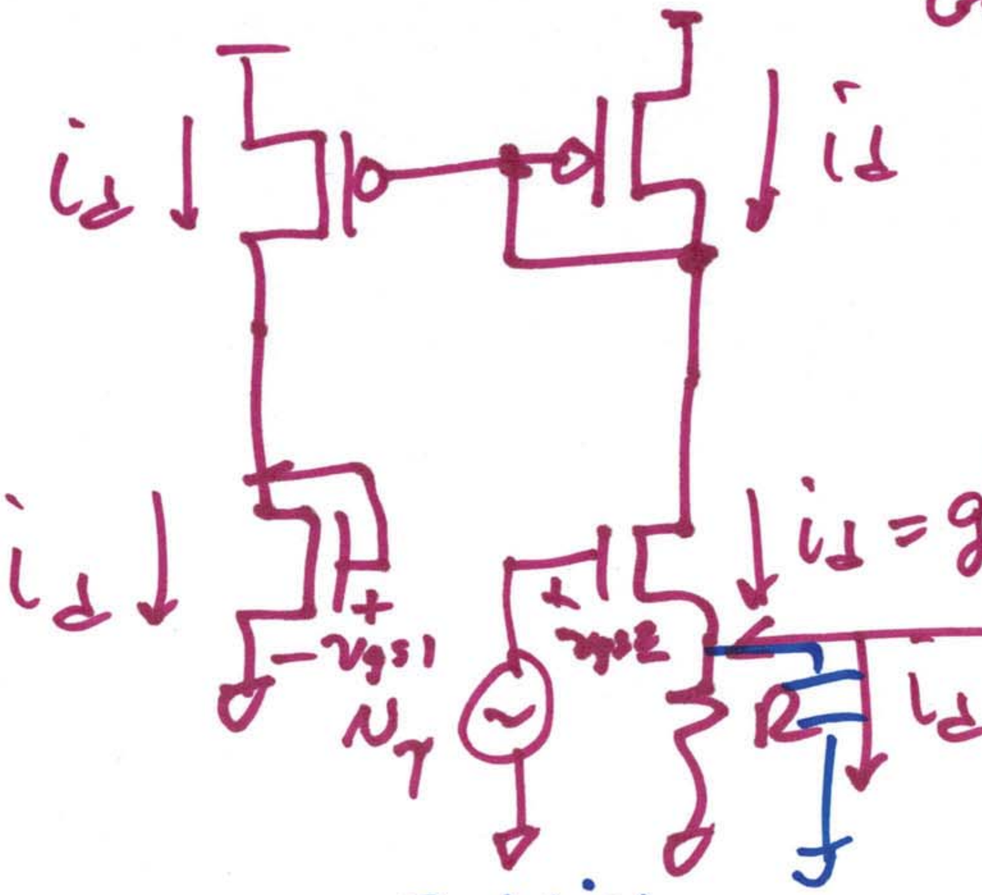

Vsat
-
+
I
V
V
I
R


5V
3
2
1


$i_d = g_m v_{gs}$
+
v_{gs}
-

GAW



$$\frac{v_{gs1}}{v_T} = \frac{\cancel{\frac{1}{g_{m1}}} \;\; \frac{1}{\sqrt{2\beta_n I_{REF}}}}{\cancel{\frac{1}{g_{m2}}} + R} < 1$$

$$\frac{1}{\sqrt{2\beta_n \cdot K I_{REF}}}$$

$$\frac{1}{\sqrt{K}+1}$$

$$g_m = \frac{A}{V}$$

$$\frac{\mu A}{V}$$

$$i_d = g_{m2} v_{gs2}$$

$$i_d \cdot R$$

$$i_d / g_{m2}$$

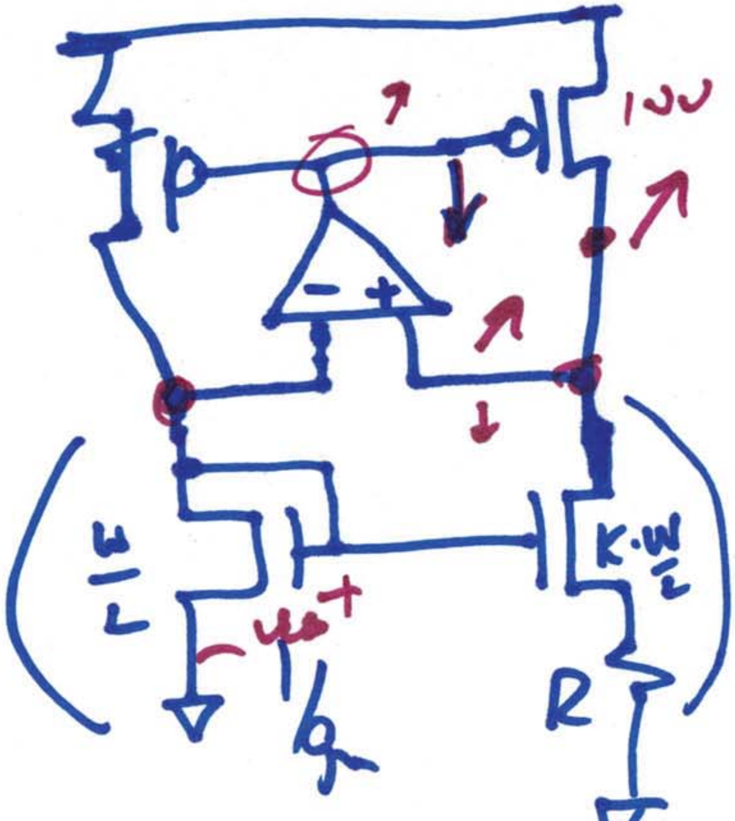
Positive is good!

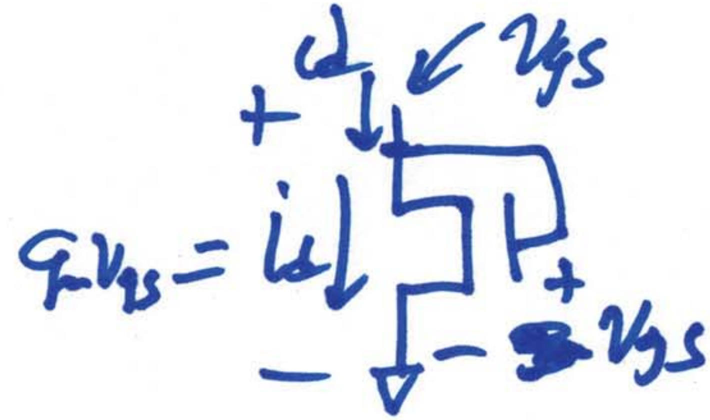
$$v_T = \cancel{v_{gs2}} + i_d \cdot R$$

$$g_{m1} v_{gs1} = i_d$$

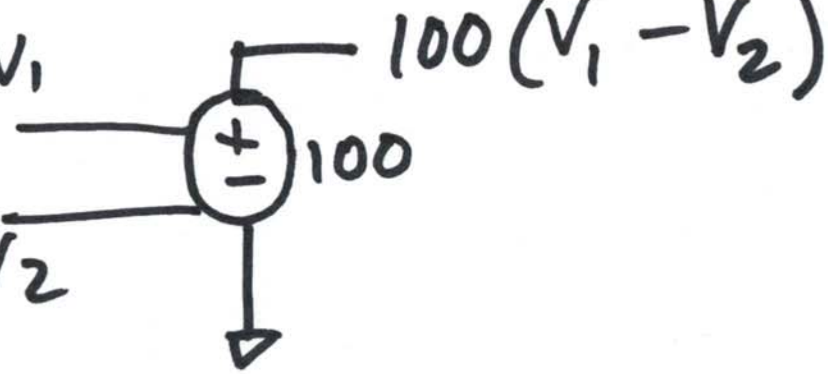
$$v_{gs1} = \frac{i_d}{g_{m1}}$$

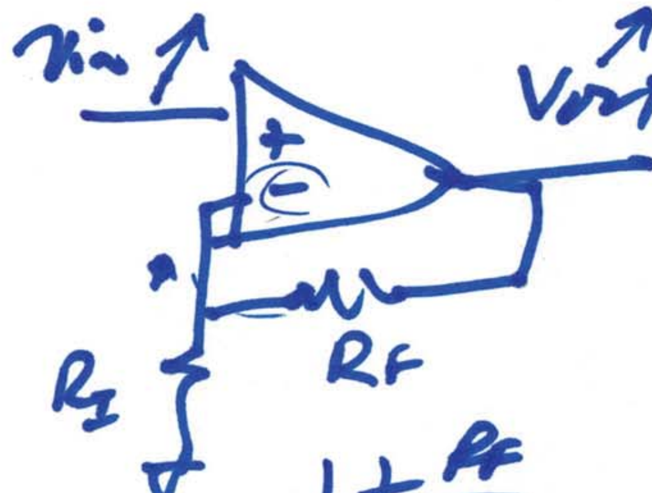
$$v_T = i_d\left(\frac{1}{g_{m2}} + R\right)$$





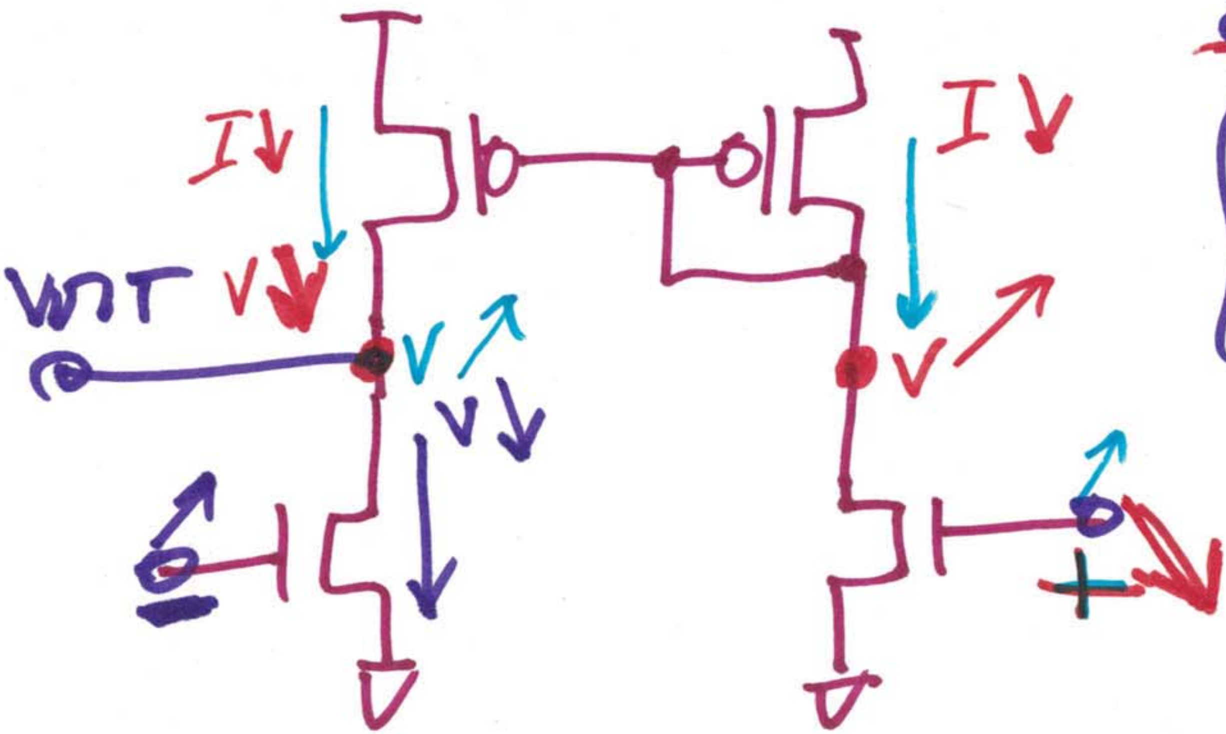
$$\frac{v_{gs}}{i_d} = \frac{1}{g_m}$$

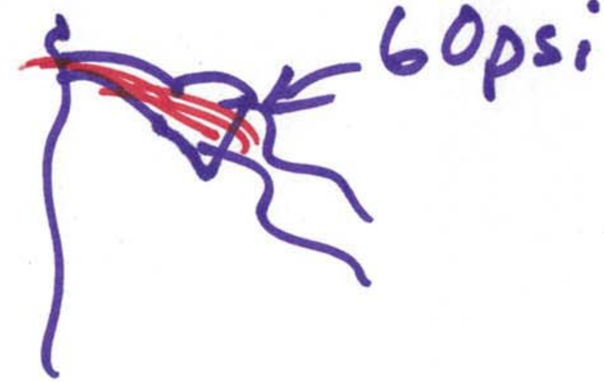


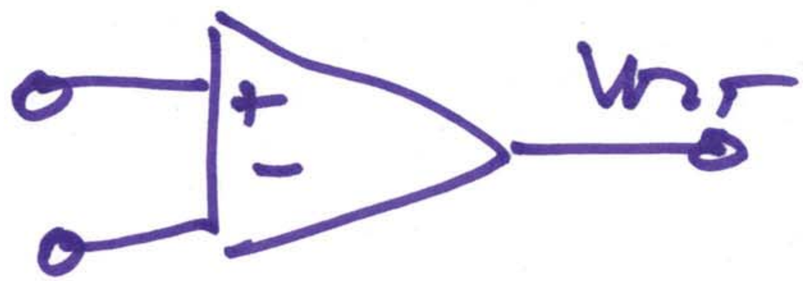


$$1 + \frac{R_F}{R_I}$$

Negative







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