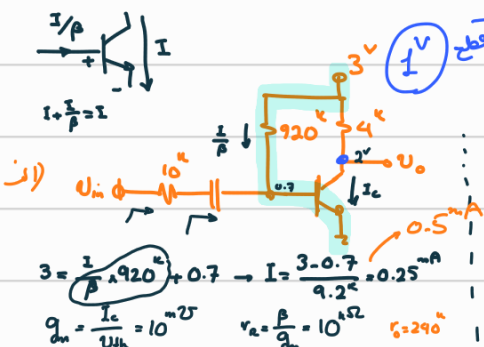


تمرین سری هشتم (بخش اختیاری) (sp) اسپاس

در مدل زیر $V_{A_{pnp}} = 50V$, $\beta_{pnp} = 50$, $V_{A_{npn}} = 60V$, $\beta_{npn} = 100$, $|V_{CE_{sat}}| = 0.2V$, $|V_{BE_{on}}| = 0.7V$



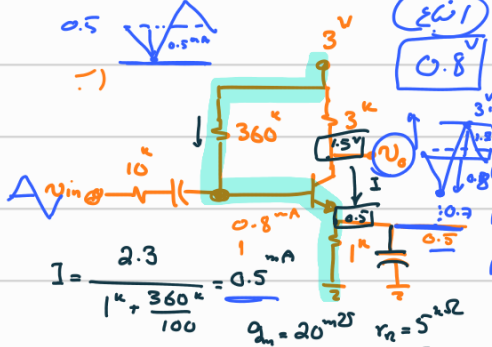
$$3 = \frac{I}{\beta} \cdot 920k + 0.7 \rightarrow I = \frac{3 - 0.7}{9.2k} = 0.25mA$$

$$g_m = \frac{I_c}{V_{th}} = 10^{-2}S \quad r_e = \frac{\beta}{g_m} = 10^4\Omega \quad r_o = 240\Omega$$

$$R_{in} = 920k \parallel 10k \approx 10k \quad R_{th} = 20k$$

$$\frac{v_o}{v_{in}} = \frac{R_{in}}{R_{in} + 10k} \times (-g_m(r_o \parallel 4k)) = -20$$

$$R_{out} = 4k \parallel 240\Omega = 3.934k \approx 4k$$



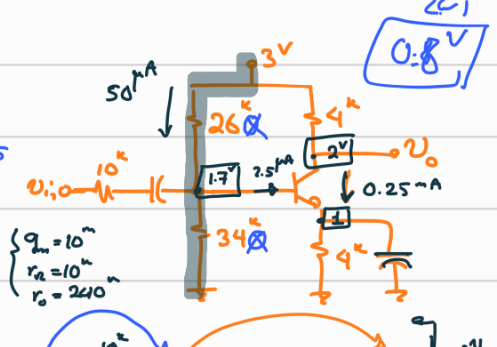
$$I = \frac{2.3}{1k + \frac{360k}{100}} = 0.5mA$$

$$g_m = 20^{-2}S \quad r_e = 5k\Omega \quad r_o = 120k\Omega$$

$$R_{in} = 360k \parallel 15k = 5k$$

$$\frac{v_o}{v_{in}} = \frac{R_{in}}{R_{in} + 10k} \times (-g_m(3k \parallel r_o)) = -20$$

$$R_{out} = 3k \parallel r_o \approx 3k$$

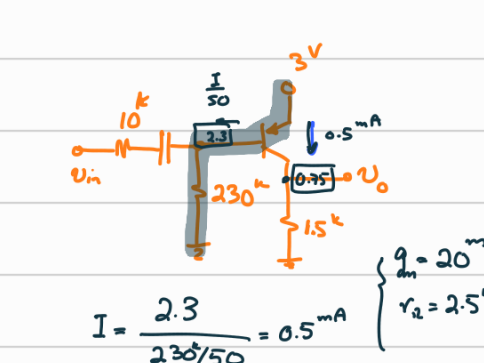


$$g_m = 10^{-2}S \quad r_e = 10k\Omega \quad r_o = 240\Omega$$

$$R_{th} = 34k \parallel 26k \parallel r_e = 5.9k$$

$$\frac{v_o}{v_{in}} = \frac{R_{in}}{R_{in} + 10k} \times (-g_m(4k \parallel r_o)) = -14.8$$

$$R_{out} = 4k \parallel r_o \approx 4k$$



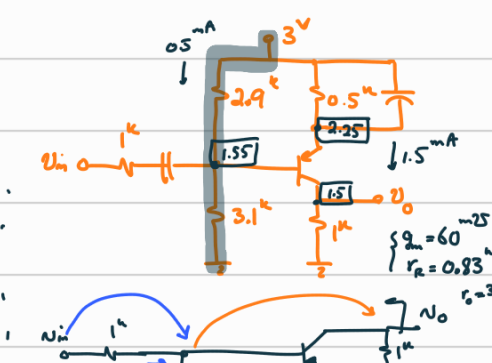
$$I = \frac{2.3}{230k/50} = 0.5mA$$

$$g_m = 20^{-2}S \quad r_e = 2.5k\Omega$$

$$R_{in} = 230k \parallel r_e = 2.5k$$

$$\frac{v_o}{v_{in}} = \frac{2.5}{2.5 + 10k} \times (-g_m(1.5k \parallel r_o)) = -6$$

$$R_{out} = 1k \parallel r_o \approx 1k$$

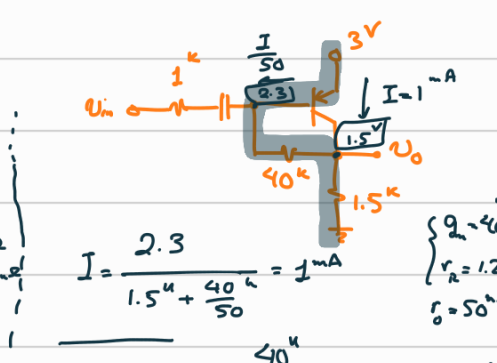


$$g_m = 60^{-2}S \quad r_e = 0.83k\Omega \quad r_o = 33k\Omega$$

$$R_{in} = 3.1k \parallel 2.2k \parallel r_e = 0.53k$$

$$\frac{v_o}{v_{in}} = \frac{0.53}{0.53 + 1k} \times (-g_m(1k \parallel r_o)) = -20$$

$$R_{out} = 1k \parallel r_o \approx 1k$$

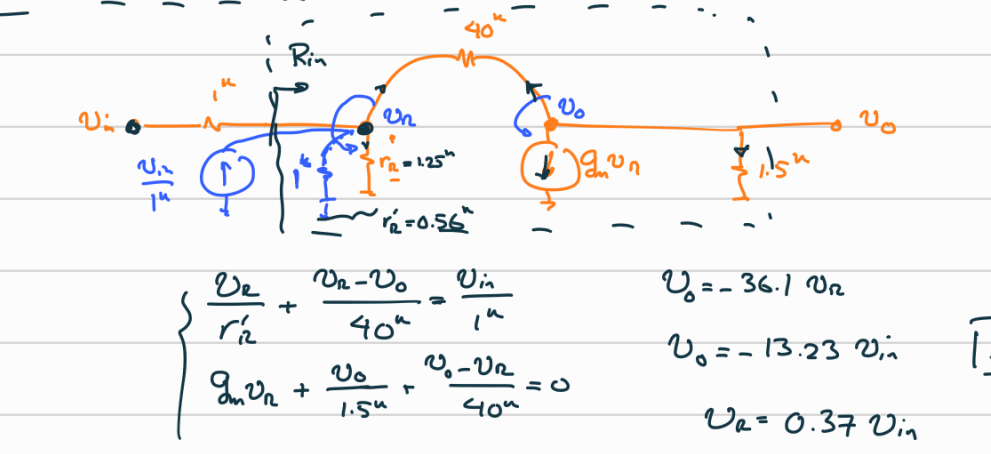


$$I = \frac{2.3}{1.5k + \frac{40k}{50}} = 1mA$$

$$g_m = 40^{-2}S \quad r_e = 1.25k\Omega \quad r_o = 50k\Omega$$

$$\frac{v_o}{v_{in}} = \frac{R_{in}}{R_{in} + 1k} = 0.366$$

$$R_{th} = 0.57k$$



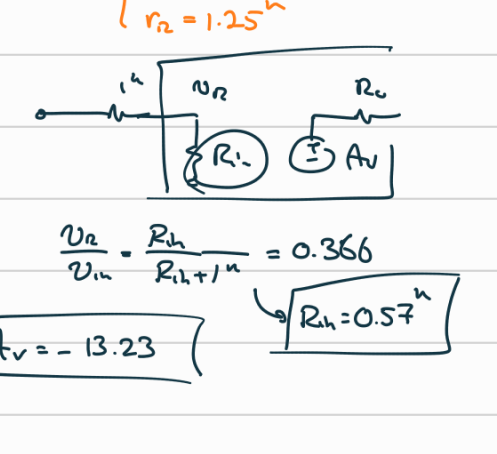
$$\frac{v_o}{r_e} + \frac{v_o - v_n}{40k} = \frac{v_{in}}{1k}$$

$$g_m v_n + \frac{v_o}{1.5k} + \frac{v_o - v_n}{40k} = 0$$

$$v_o = -36.1 v_n$$

$$v_o = -13.23 v_{in}$$

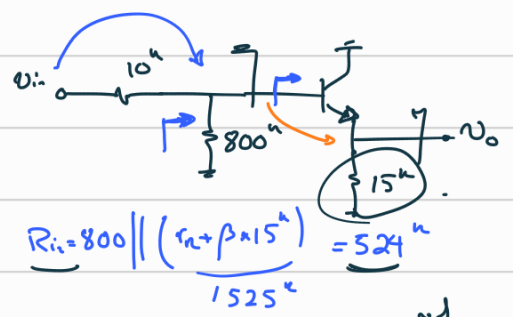
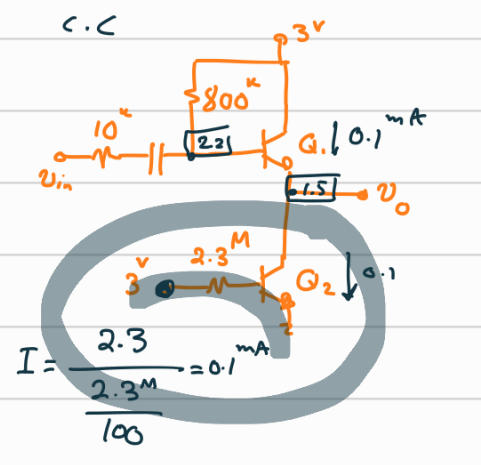
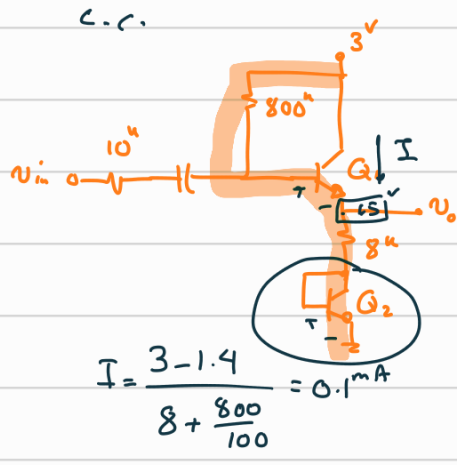
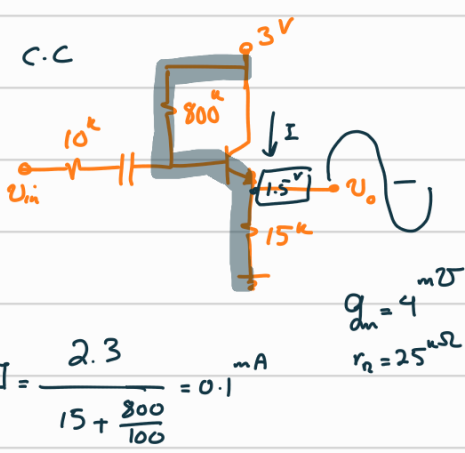
$$v_o = 0.37 v_{in}$$



$$\frac{v_o}{v_{in}} = \frac{R_{th}}{R_{th} + 1k} = 0.366$$

$$R_{th} = 0.57k$$

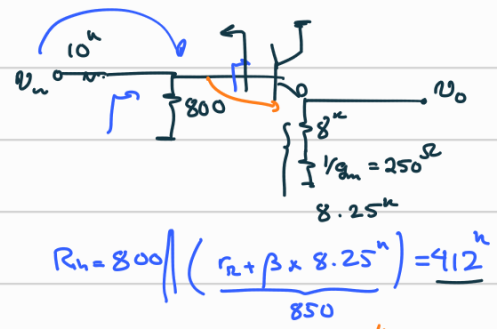
$$A_v = -13.23$$



$\frac{v_o}{v_{in}} = \frac{R_{in}}{R_{in} + 10 \text{ k}} \times \frac{15 \text{ k}}{15 \text{ k} + \frac{1}{g_m}} \approx 0.965$

0.9812

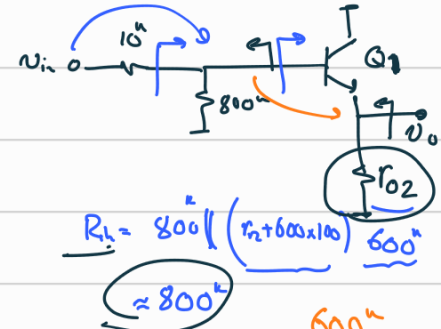
$R_{out} = 15 \text{ k} \parallel \frac{10 \text{ k} + 25 \text{ k}}{100} \approx 0.35 \text{ k}$



$\frac{v_o}{v_{in}} = \frac{R_{in}}{R_{in} + 10 \text{ k}} \times \frac{8.25 \text{ k}}{8.25 \text{ k} + 0.25 \text{ k}} \approx 0.976$

$0.947 \approx 1$

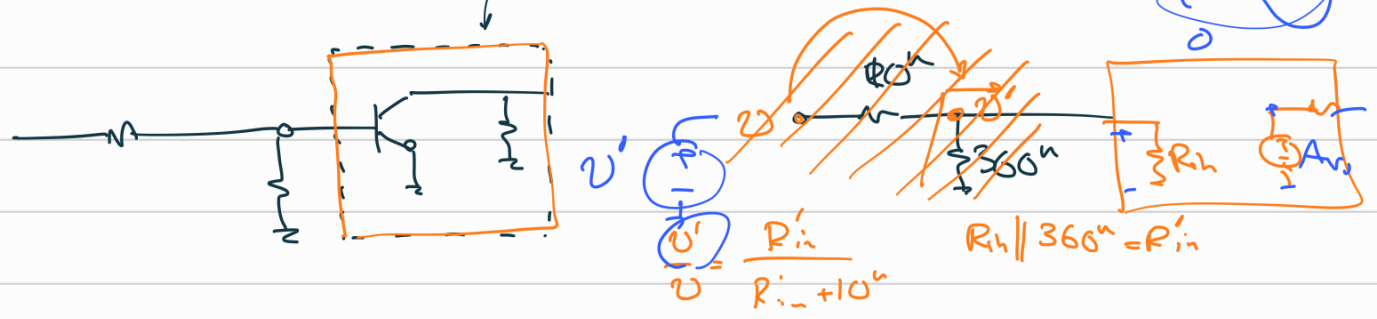
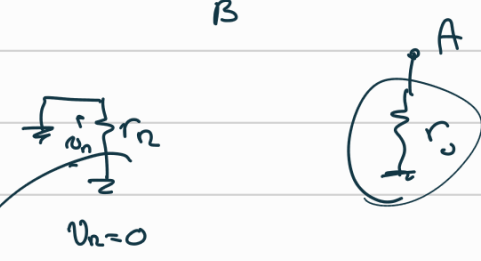
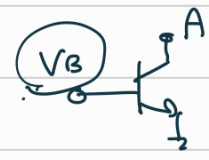
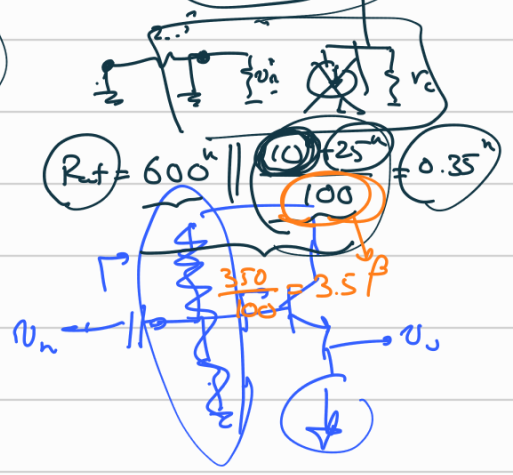
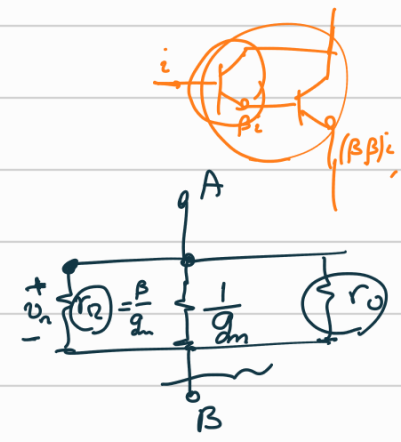
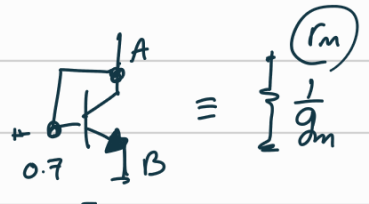
$R_{out} = 8.25 \text{ k} \parallel \frac{10 \text{ k} + 25 \text{ k}}{100} = 0.35 \text{ k}$

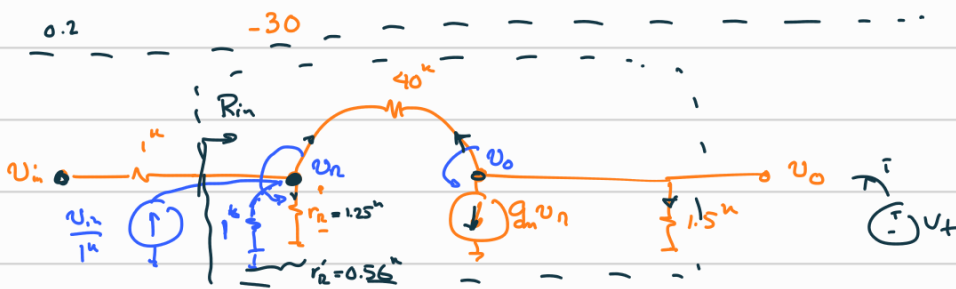


$\frac{v_o}{v_{in}} = \frac{R_{in}}{R_{in} + 10 \text{ k}} \times \frac{600 \text{ k}}{600 \text{ k} + \frac{1}{g_m}} \approx 0.9876$

$0.987 \approx 1$

$R_{out} = 600 \text{ k} \parallel \frac{10 \text{ k} + 25 \text{ k}}{100} = 0.35 \text{ k}$





$$\begin{cases} g_m = 40 \\ r_{be} = 1.25k\Omega \end{cases}$$



$$\frac{v_o}{v_{be}} = \frac{R_L}{R_L + 1k} = 0.366$$

$$\begin{cases} \frac{v_{be}}{r_{be}} + \frac{v_{be} - v_o}{40k} = \frac{v_i}{1k} \\ g_m v_{be} + \frac{v_o}{1.5k} + \frac{v_o - v_{be}}{40k} = 0 \end{cases}$$

$$v_o = -36.1 v_{be}$$

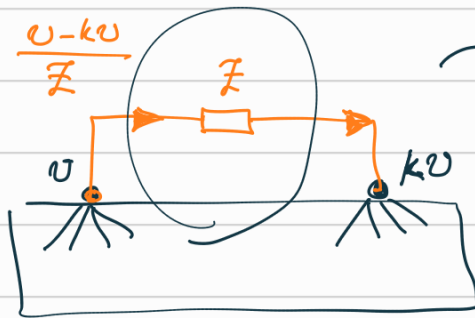
$$v_o = -13.23 v_i$$

$$v_{be} = 0.37 v_i$$

$$|A_v| = -13.23$$

$$R_{th} = 0.57k\Omega$$

(قضية اخرى)



$$\frac{v}{Z_1} = \frac{v - kv}{Z}$$

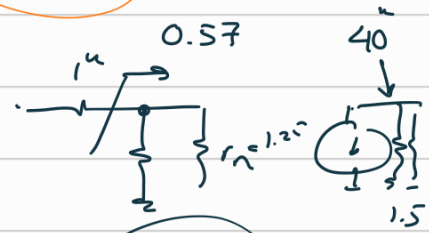


$$\frac{-kv}{Z_2} = \frac{v - kv}{Z}$$

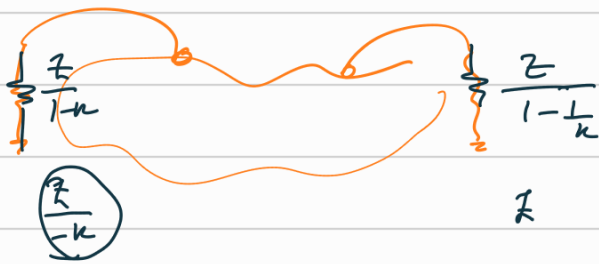
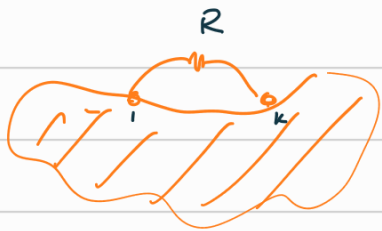
$$Z_2 = \frac{Zk}{k-1}$$

$$Z_2 = \frac{Z}{1 - \frac{1}{k}}$$

$$k \gg 1$$

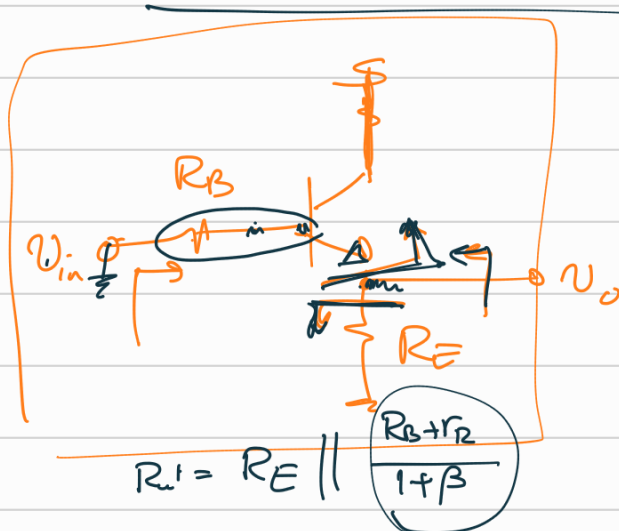
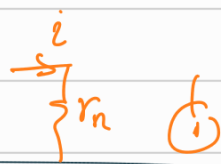


$$\frac{40k}{1 + 36.1} = 1.08k\Omega$$



$$k = -36.1$$

$$R_{out} = 1.5k \parallel 40k \approx 1.5k = 1.44k\Omega$$



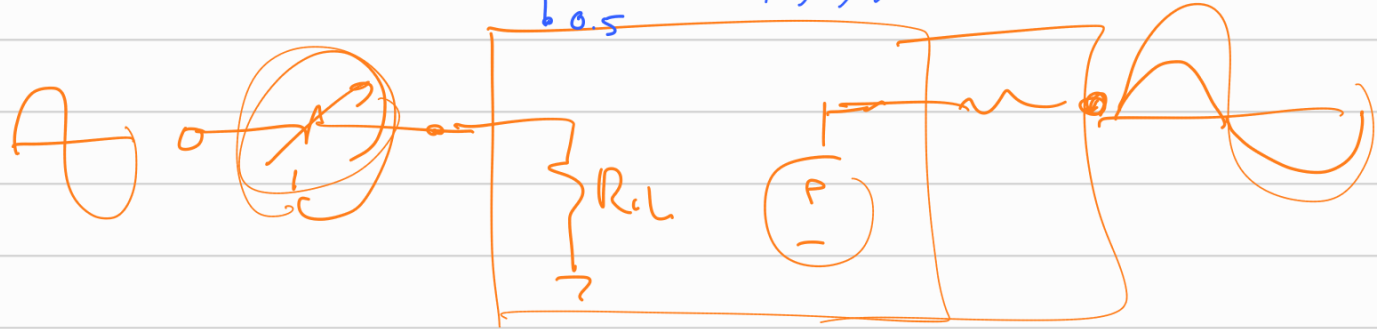
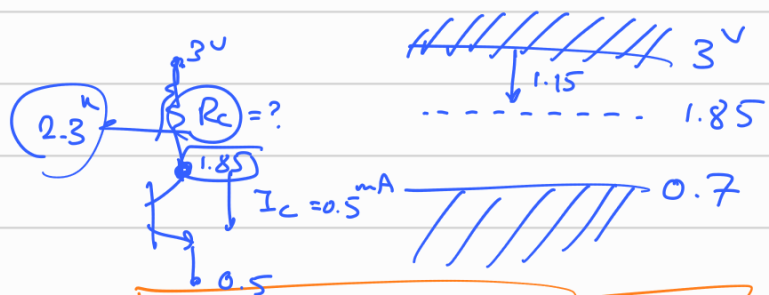
$$\frac{v_o}{v_{be}} = \frac{R_C}{R_C + \left(\frac{R_B + r_{be}}{\beta} \right)}$$

$$R_{in} = R_B + r_{be} + (1 + \beta) R_E$$

$$R_{out} = R_C \parallel \frac{R_B + r_{be}}{1 + \beta}$$



$$R_{in} = R_E \parallel \frac{R_B + r_{be}}{1 + \beta}$$



TF

trans