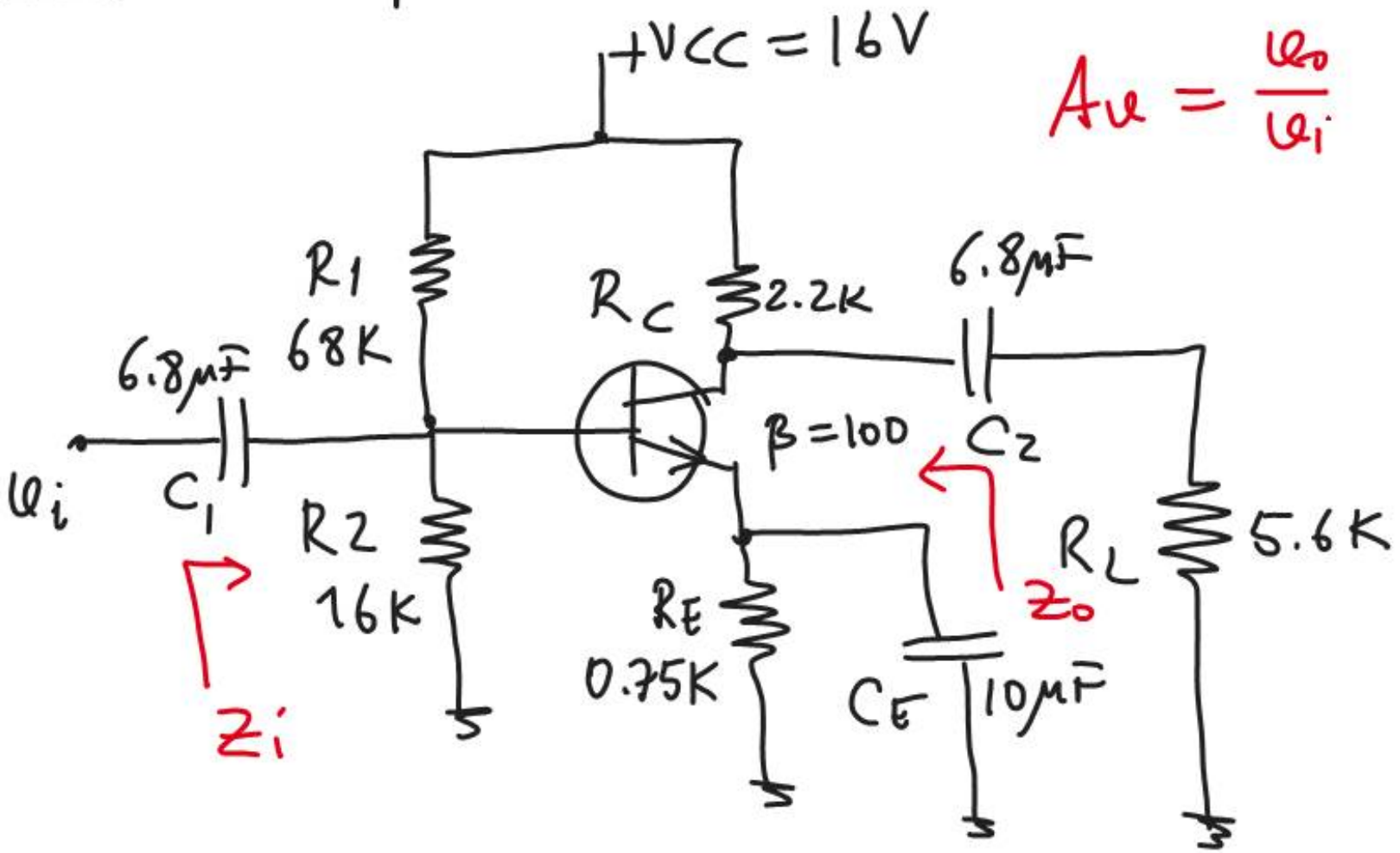
22.05.2012

©

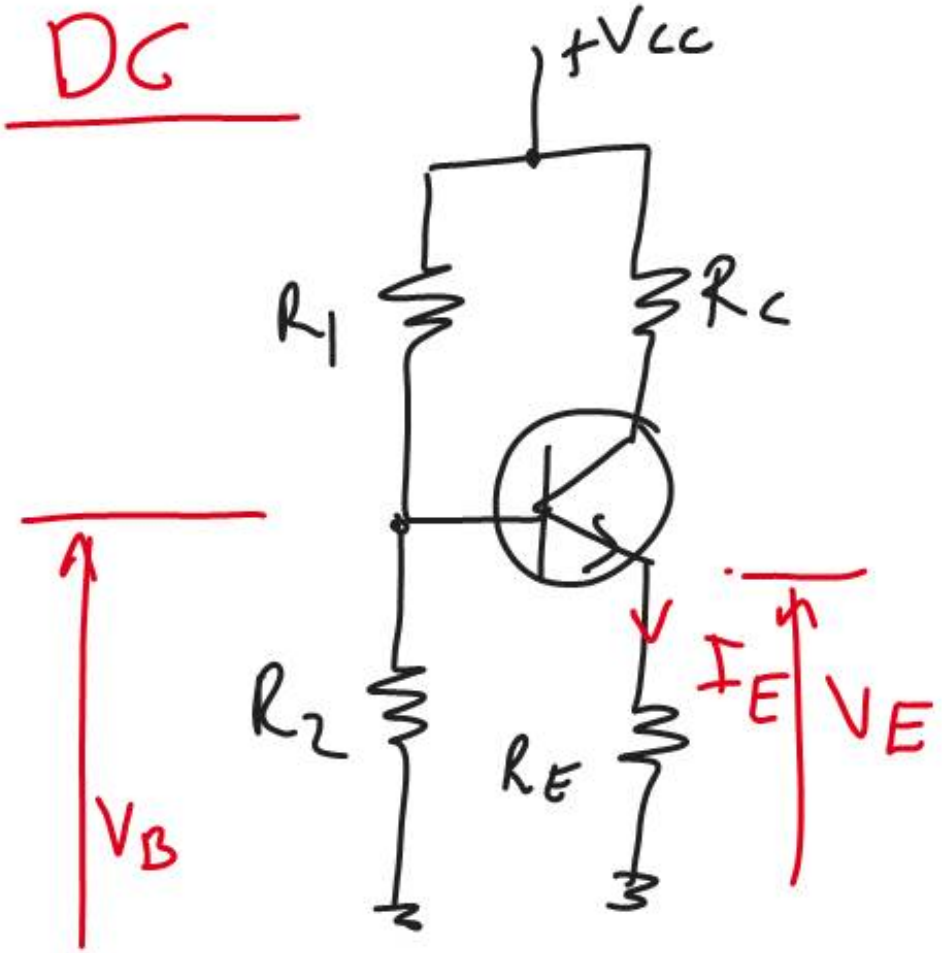
Last lecture this year.

Ex: Chapter 5 Problem 40



$$A_v = \frac{v_o}{v_i}$$

DC



$$V_B \cong \frac{V_{CC}}{R_1+R_2} = \frac{16}{(68+16)\times 10^3} \times 16 \times 10^3$$

$$\cong 3\,V$$

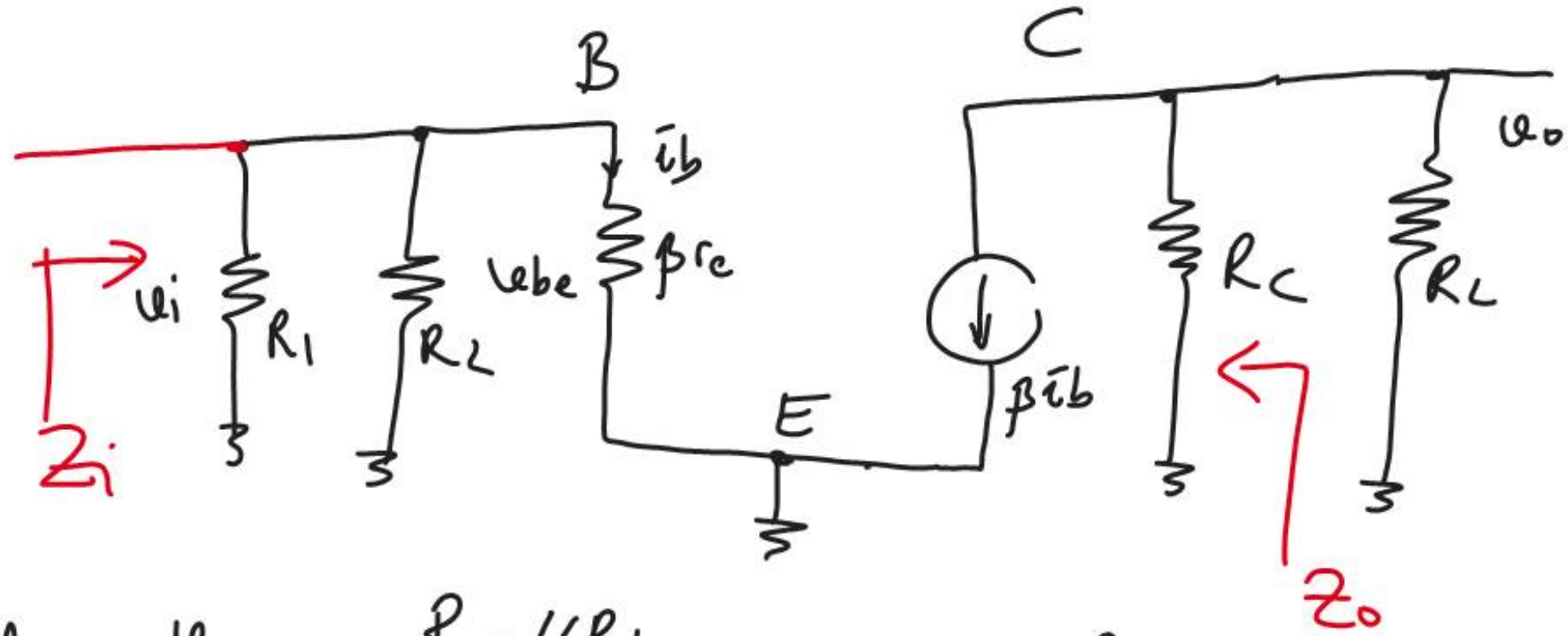
$$V_E = V_B - V_{BE} = 3 - 0.7 = 2.3\,V$$

$$I_E = \frac{V_E}{R_E} = \frac{2.3}{0.75\times 10^3} \cong 3\times 10^{-3}\,A$$

$$r_e = \frac{V_T}{I_E} = \frac{26\times 10^{-3}}{3\times 10^{-3}} \cong 9\,\Omega$$

AC Analysis

$A_v = ?$

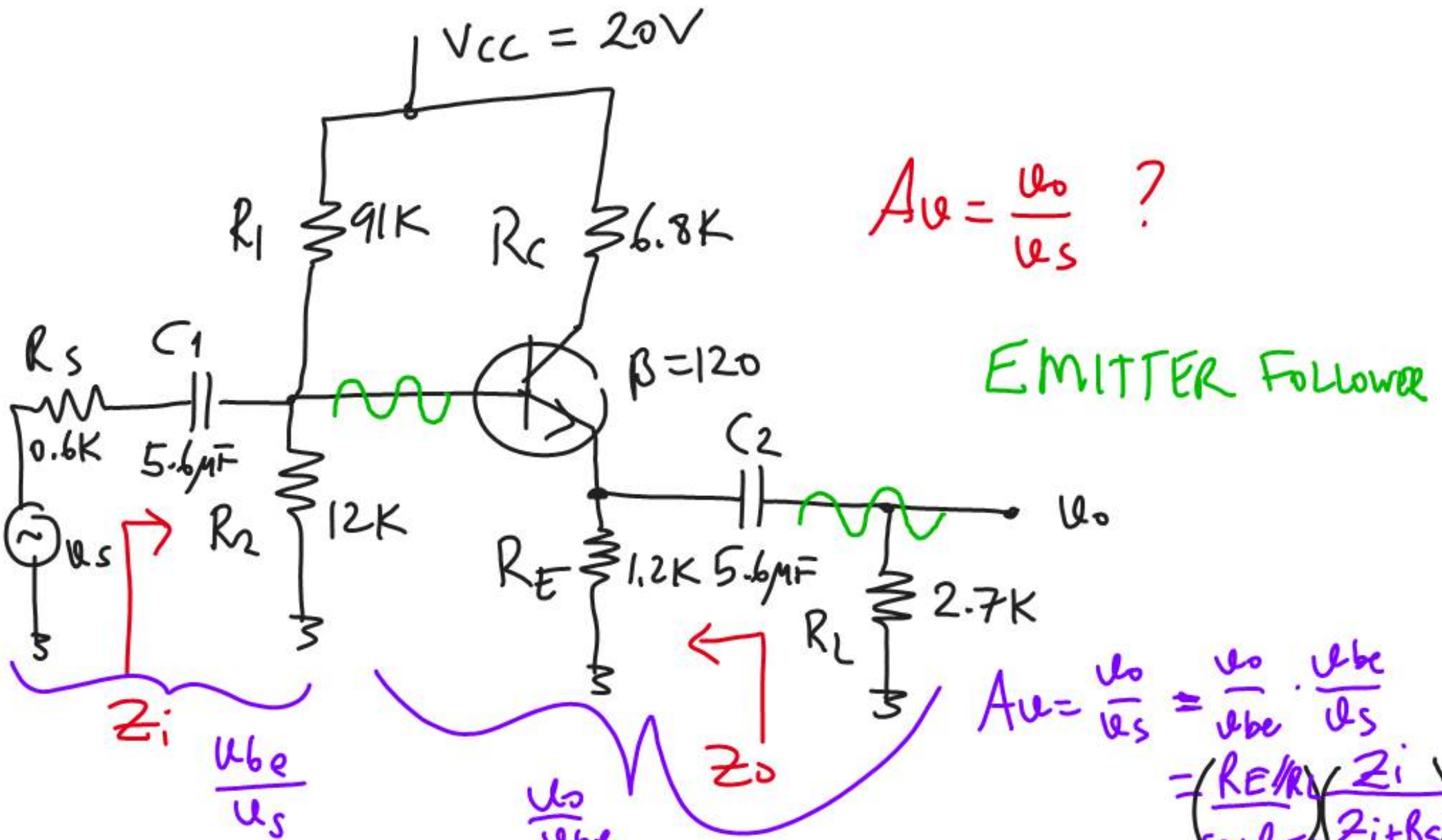


$$A_v = \frac{v_o}{v_i} = -\frac{R_C // R_L}{r_e}$$

$$Z_o \cong R_C$$

$$Z_i = R_1 // R_2 // \beta r_e$$

Ex Chapter 5 Problem 43



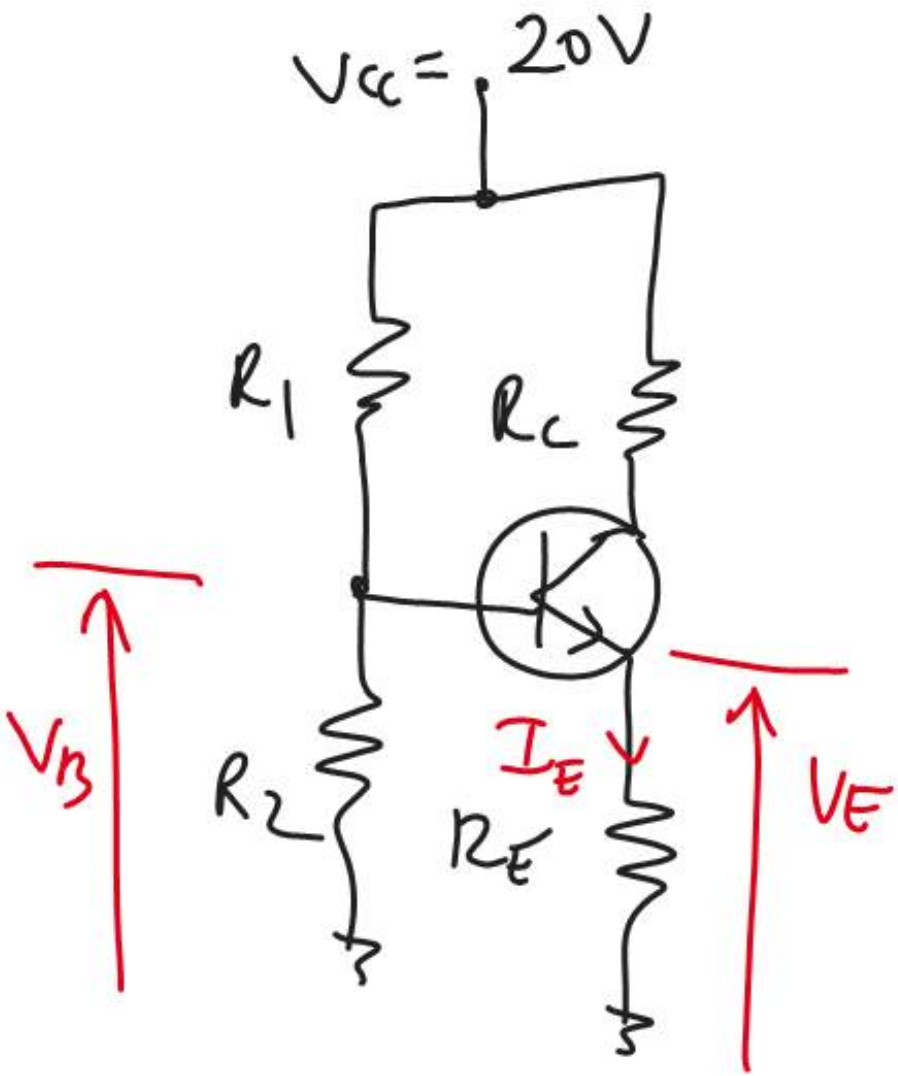
$A_v = \frac{v_o}{v_s}$?

EMITTER FOLLOWER

$$A_v = \frac{v_o}{v_s} = \frac{v_o}{v_{be}} \cdot \frac{v_{be}}{v_s}$$

$$= \left(\frac{R_E /\!/ R_L}{r_e + R_E /\!/ R_L}\right)\left(\frac{Z_i}{Z_i + R_s}\right)$$

DC Analysis



$$V_B = \frac{R_2}{R_1+R_2} \cdot V_{cc} = \frac{20}{(91+12)} \cdot 12$$

$$V_B \cong 2.3\,V$$

$$V_E = V_B - 0.7 = 2.3 - 0.7$$

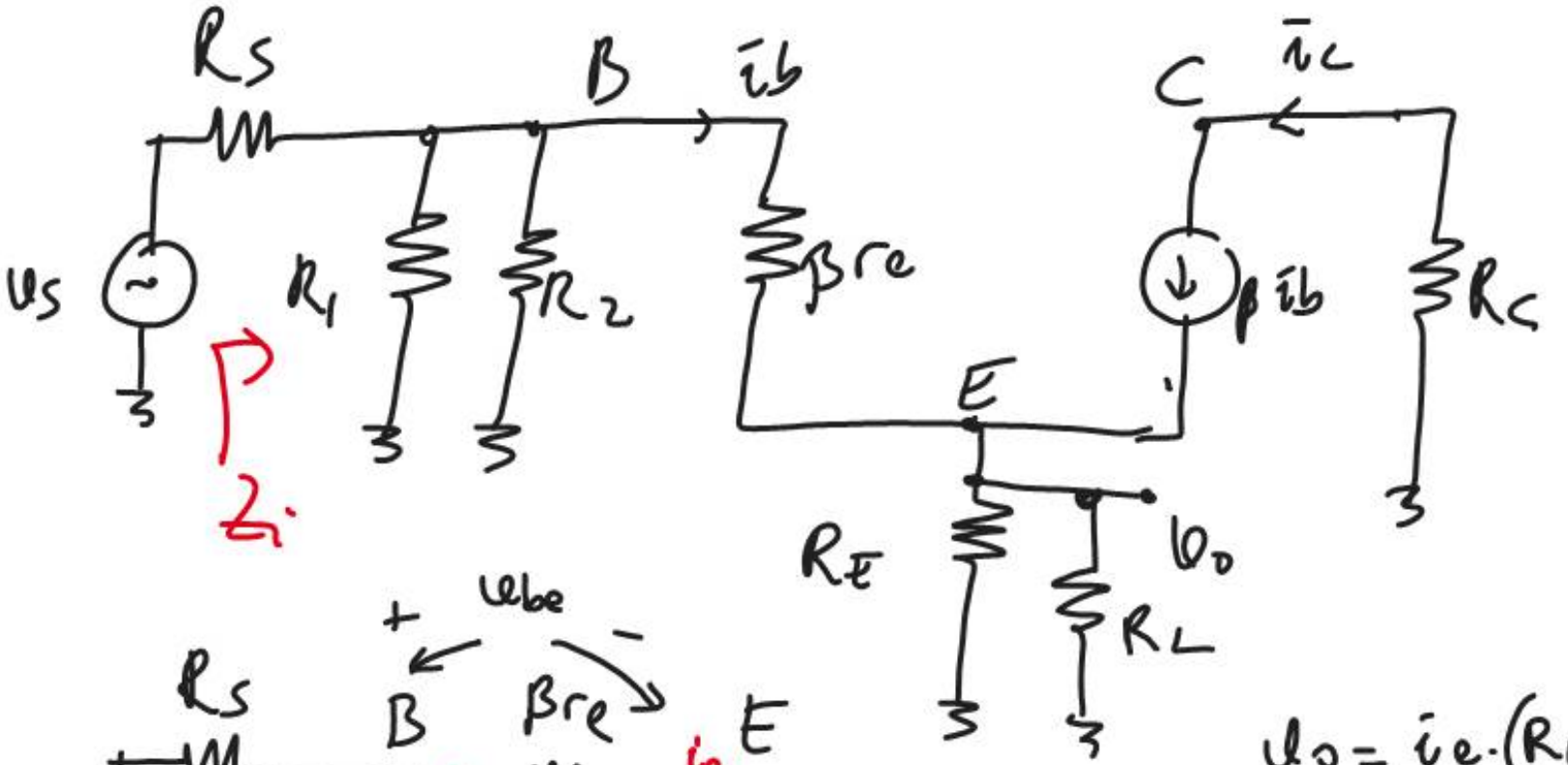
$$V_E = 1.6\,V.$$

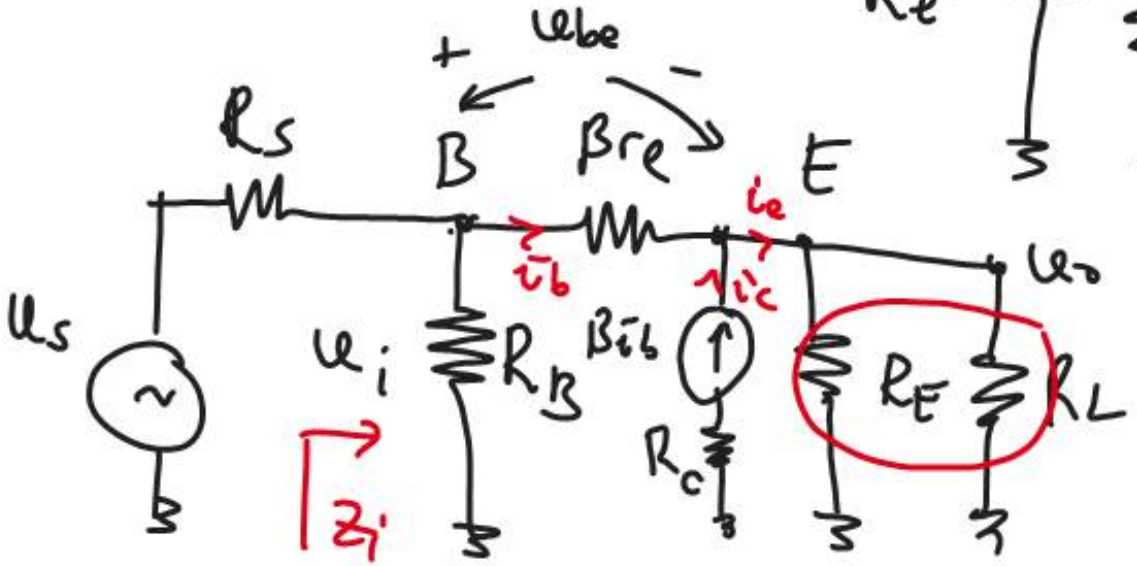
$$I_E = \frac{V_E}{R_E} = \frac{1.6}{1.2\times10^{3}} = 1.3\times10^{-3}\,A$$

$$= 1.3\,mA$$

$$r_e = \frac{V_T}{I_E} = \frac{26\times10^{-3}}{1.3\times10^{-3}} = 20\,\Omega$$

AC Analysis

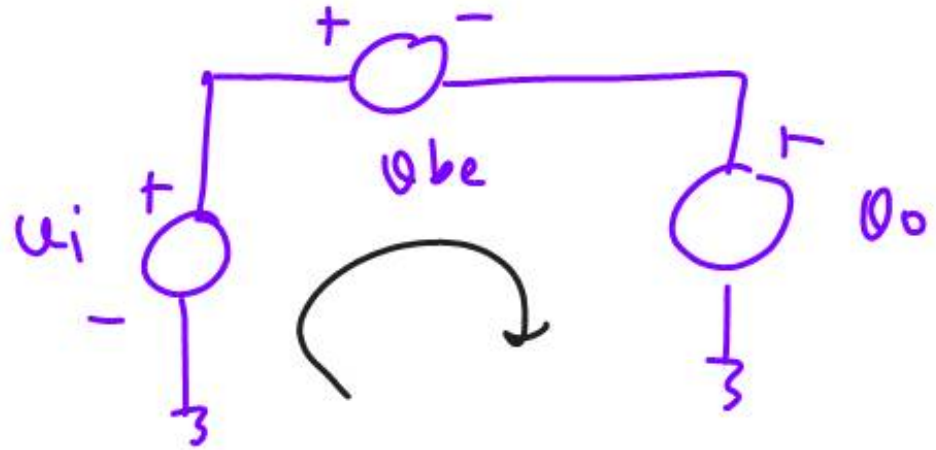




$$v_o = i_e \cdot (R_L // R_E)$$

$$= (\beta+1)\,\bar{i}_b \cdot (R_L // R_E)$$

$$v_o = (\beta+1)\frac{v_{be}}{\beta r_e} \cdot (R_L // R_E)$$



$$v_i - v_b - v_o = 0$$

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

$$v_o = \frac{(\beta+1)}{\beta \cdot r_e}\,(R_E // R_L)\cdot v_{be}$$

$$v_o \cong \left(\frac{R_E // R_L}{r_e}\right)\cdot v_{be}$$

$$v_o = \frac{(R_E // R_L)}{r_e}(v_i - v_o)$$

$$v_o + \left(\frac{R_E // R_L}{r_e}\right)v_o = \left(\frac{R_E // R_L}{r_e}\right)v_i$$

$$v_o\left[1 + \frac{(R_E // R_L)}{r_e}\right] = \left(\frac{R_E // R_L}{r_e}\right)v_i$$

$$\frac{v_o}{v_i} = \frac{\frac{R_E // R_L}{r_e}}{1 + \frac{R_E // R_L}{r_e}}$$

$$\frac{v_o}{v_i} = \frac{\frac{R_E // R_L}{\cancel{r_e}}}{\frac{r_e + R_E // R_L}{\cancel{r_e}}}$$

$$\frac{v_o}{v_i} = \frac{(R_E // R_L)}{r_e + (R_E // R_L)}$$

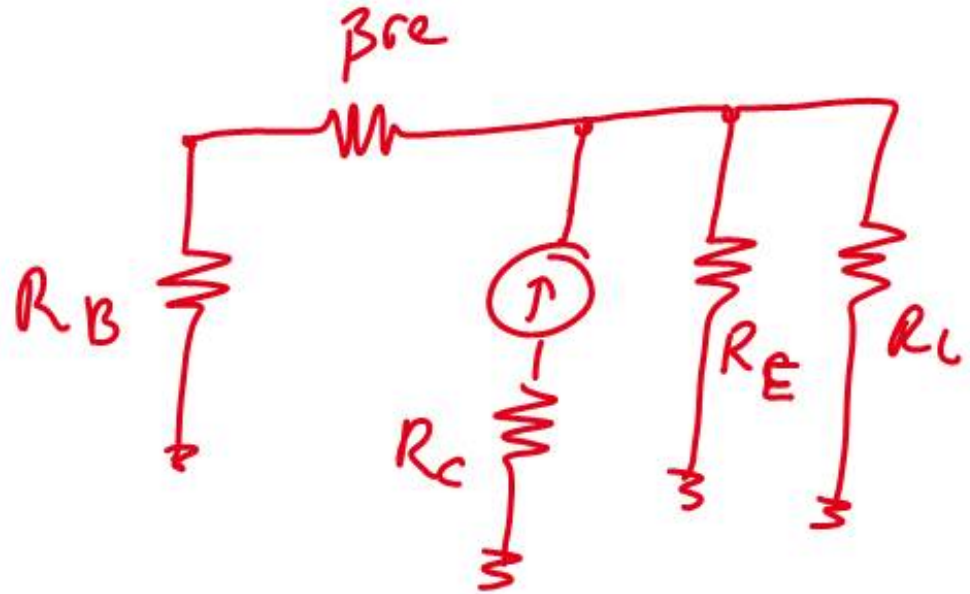
$$\frac{v_i}{v_s} = \frac{Z_i}{Z_i + R_s}$$

$$A_{v_T} = \frac{v_o}{v_s} = \frac{(R_E // R_L)}{r_e + (R_E // R_L)} \cdot \frac{Z_i}{Z_i + R_s}$$

Overall Gain

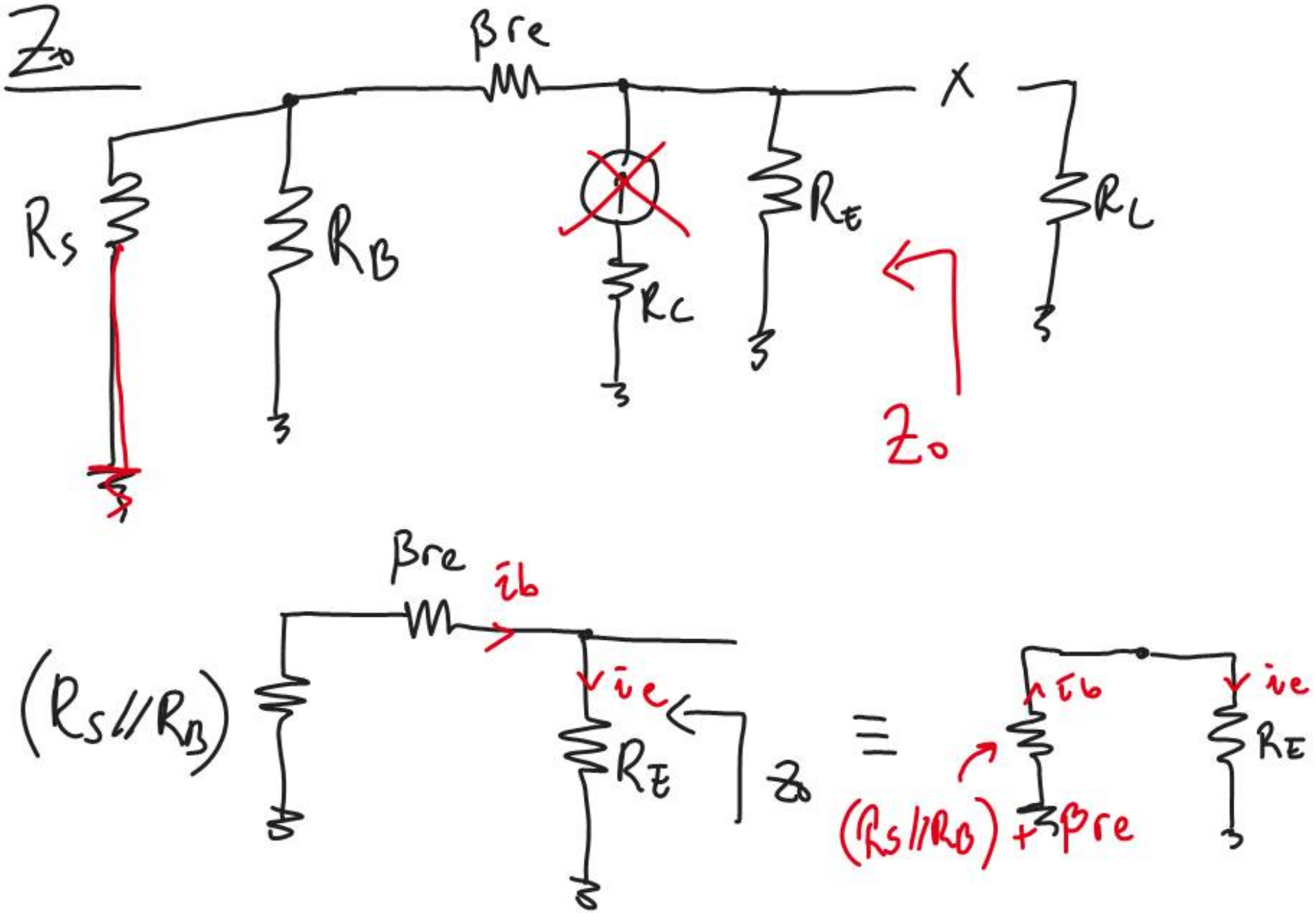
$Z_i =$

$Z_i \equiv$



$$Z_i \cong R_B // [\beta r_e + (R_E // R_L)]$$

$$R_B = R_1 // R_2$$


Zo
βre
X
Rs
RB
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(Rs//RB)
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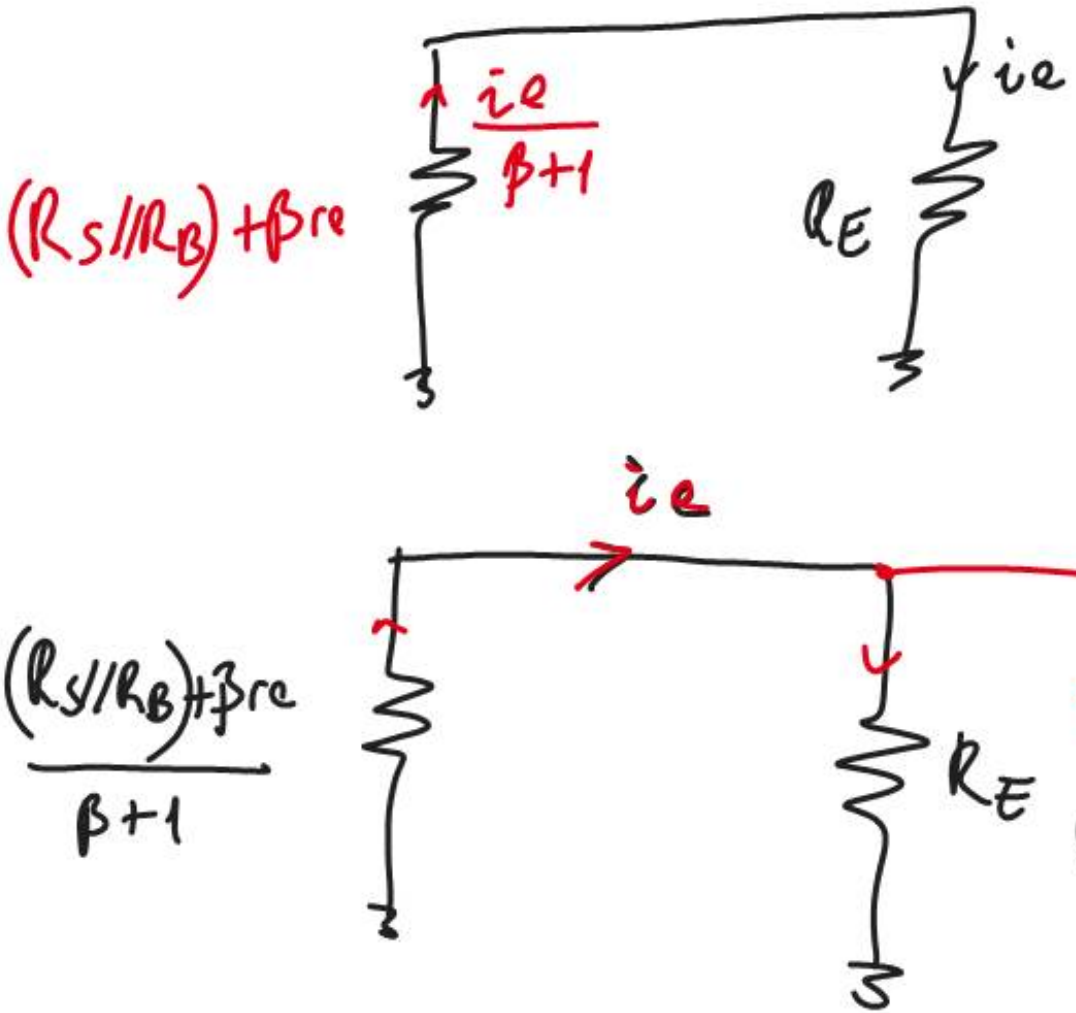
βre
RE

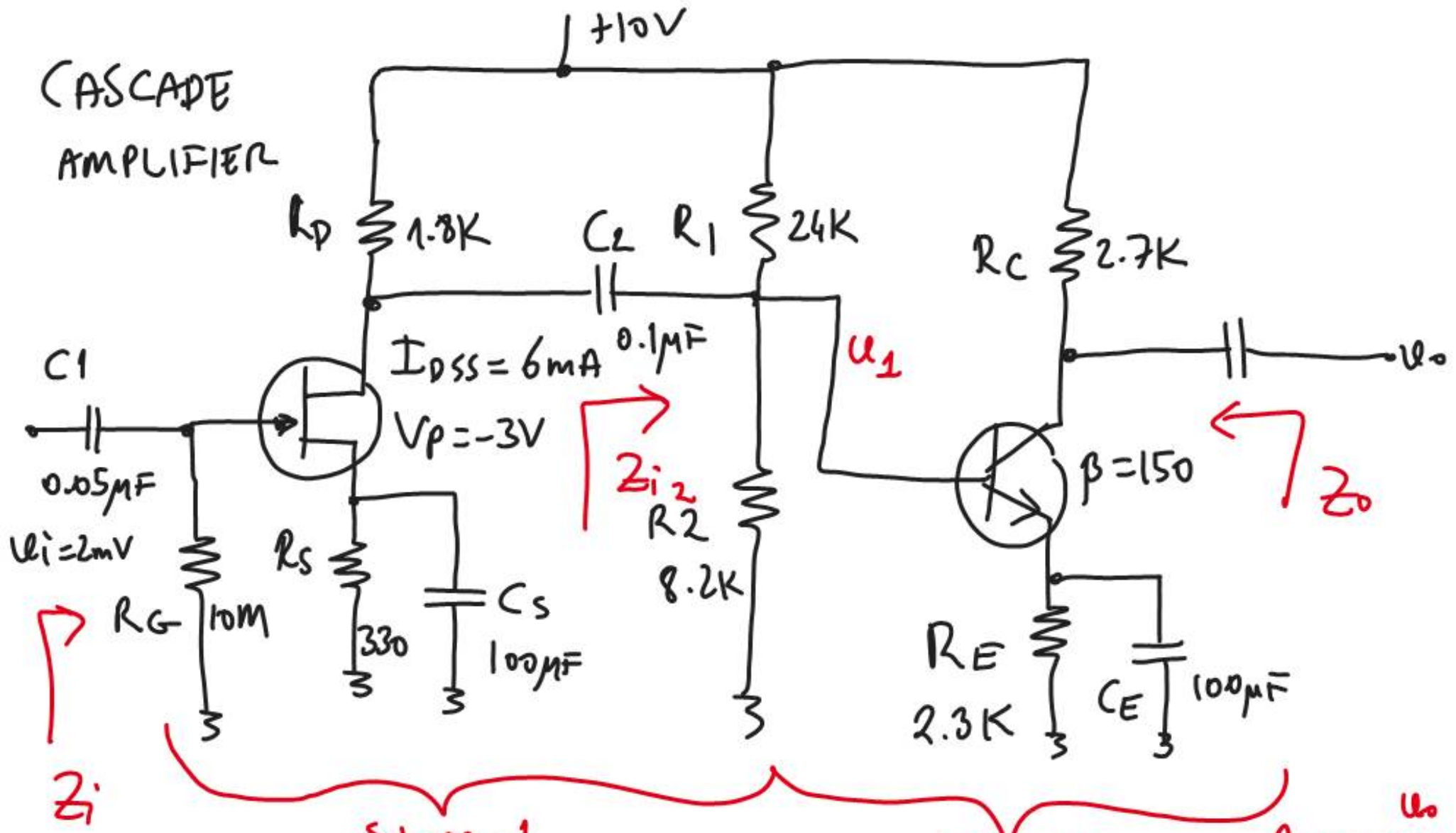


$$Z_o = R_E /\!/ \left[\frac{(R_S /\!/ R_B)+\beta r_e}{\beta+1} \right]$$

$$Z_o = \frac{V_o}{i_o}$$

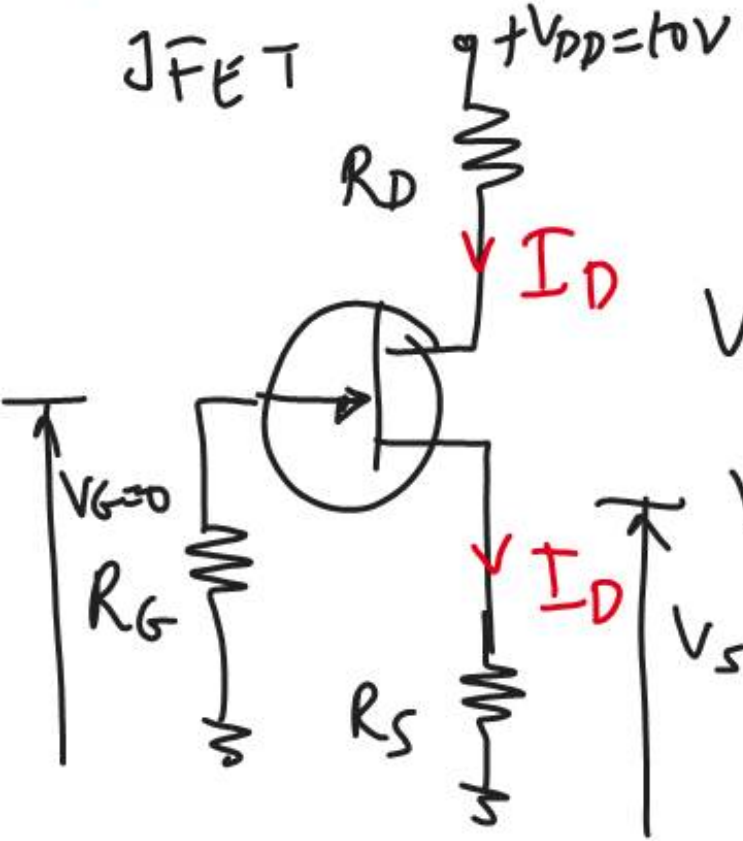
$$i_o = i_e$$

Ex: Chapter 8 Problem 54, 55, 56



$$A_{v_T} = A_{v_1} \cdot A_{v_2} = (-g_m R_D')\left(-\frac{R_c}{r_e}\right) = \frac{g_m}{r_e} \cdot R_D' \cdot R_c$$

DC Analysis



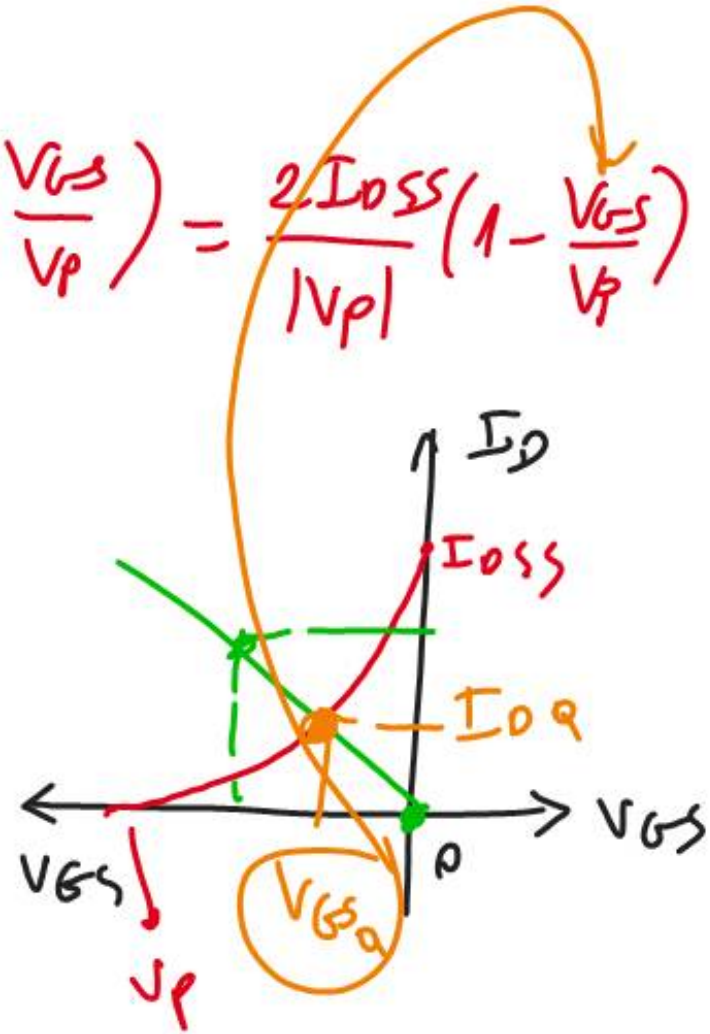
$$g_m = g_{mo}\left(1 - \frac{V_{GS}}{V_P}\right) = \frac{2I_{DSS}}{|V_P|}\left(1 - \frac{V_{GS}}{V_P}\right)$$

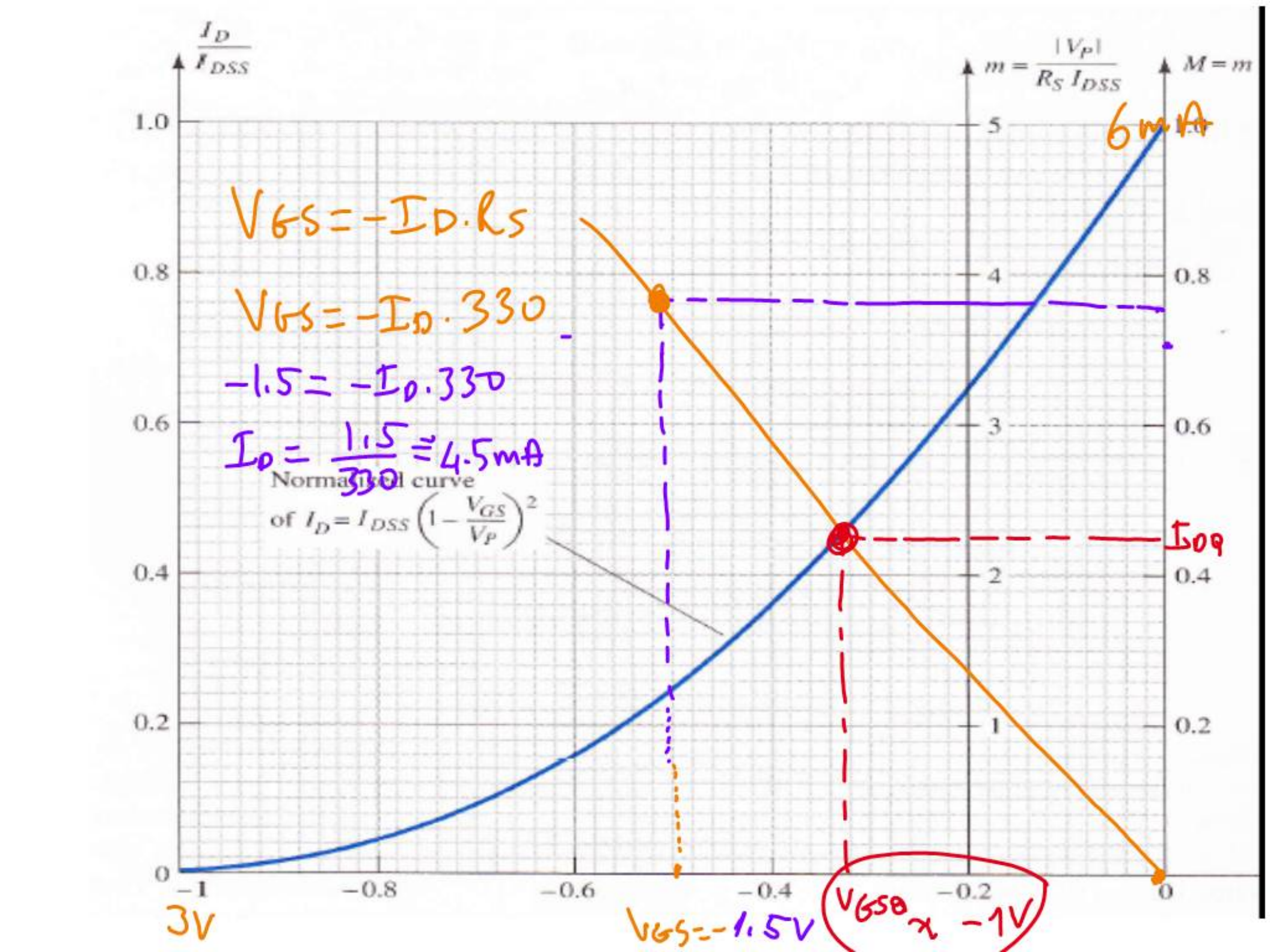
$$V_{GS} = V_G - V_S$$

$$V_{GS} = 0 - I_D \cdot R_S$$

$$\boxed{V_{GS} = -I_D \cdot R_S}$$

Load line




$\frac{I_D}{I_{DSS}}$
$m = \frac{|V_P|}{R_S I_{DSS}}$
$M = m$
1.0
0.8
0.6
0.4
0.2
0
5
4
3
2
1
−1
−0.8
−0.6
−0.4
−0.2
0
6mA
$V_{GS} = -I_D \cdot R_S$
$V_{GS} = -I_D \cdot 330$
$-1.5 = -I_D \cdot 330$
$I_D = \frac{1.5}{330} \cong 4.5mA$
Normalized curve
of $I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$
I_{DQ}
3V
$V_{GS} = -1.5V$
$V_{GSQ} \approx -1V$

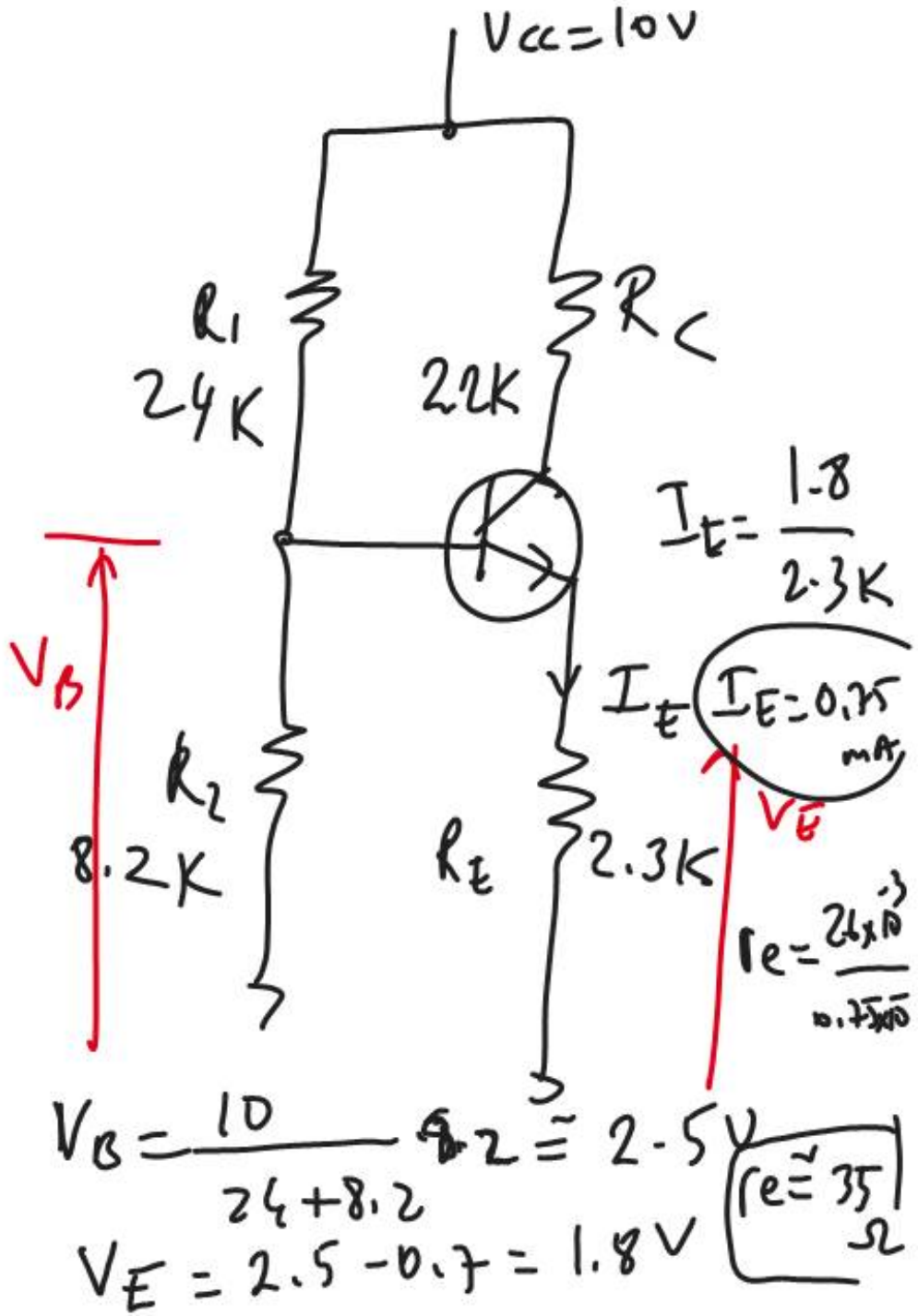
$$g_m = \frac{2 I_{DSS}}{|V_p|} \cdot \left(1 - \frac{-1}{-3}\right)$$

$$= \frac{2 \times 6 \times 10^{-3}}{6} \left(1 - \frac{1}{3}\right)$$

$$= 4 \times 10^{-3} \left(\frac{2}{3}\right)$$

$$g_m = \frac{8}{3} \times 10^{-3} \, S$$

$$\boxed{g_m \simeq 2.67 \, mS}$$

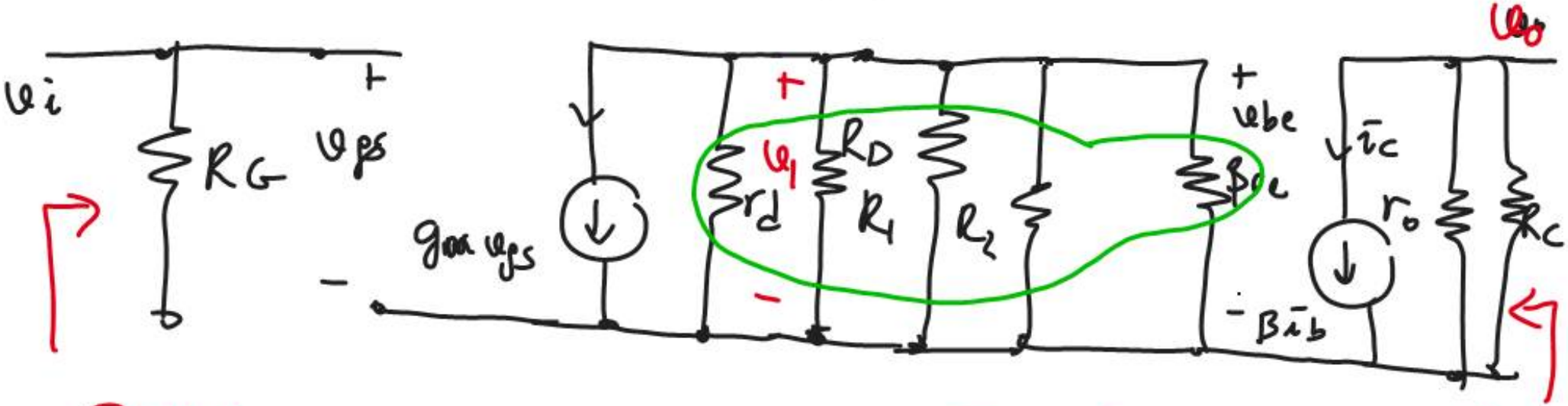


AC Analysis

$$R_D' = R_D // (\cancel{r_d} // R_1 // R_2 // \beta r_e)$$

$$A_{v_1} = \frac{v_1}{v_i} = -g_m R_D' \qquad A_{v_2} = -\frac{R_C}{r_e}$$

$$A_{v_T} = A_{v_1} \cdot A_{v_2} = +g_m R_D' \cdot \frac{R_C}{r_e}$$



$Z_i \cong R_G = 10\,M\Omega$

$Z_o \cong R_C // r_o \cong R_C$ Z_o

$Z_o = 2.7\,K\Omega$

$$A_{vT} = \frac{g_m}{r_e} R_D' \cdot R_C$$

$$= \frac{2.67 \times 10^{-3}}{35} \cdot R_D' \cdot R_C \cong \frac{2.67 \times 10^{-3}}{35} \cdot (5k) \cdot (2.7k)$$

Hope to see you next year in ECE 347