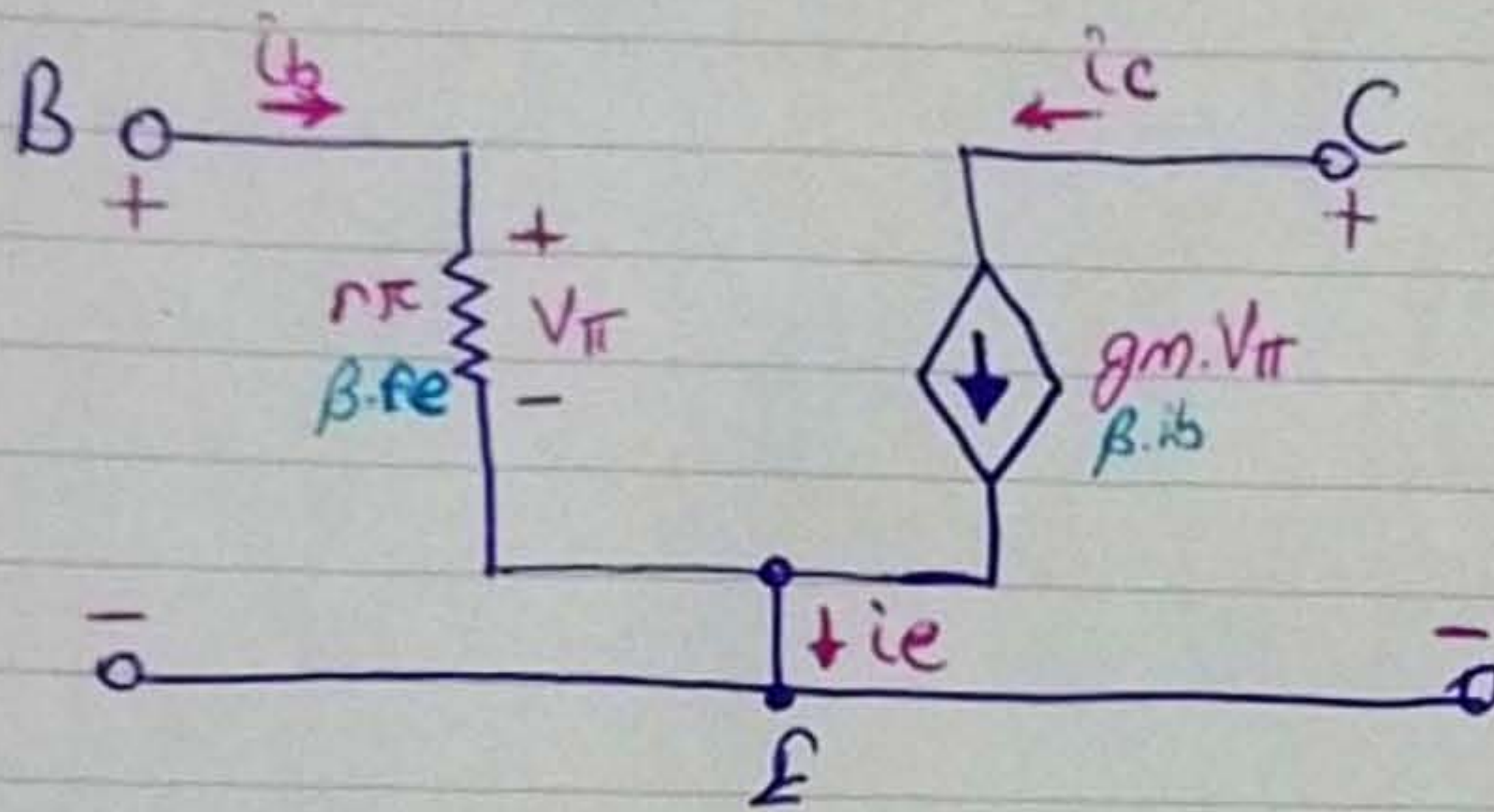
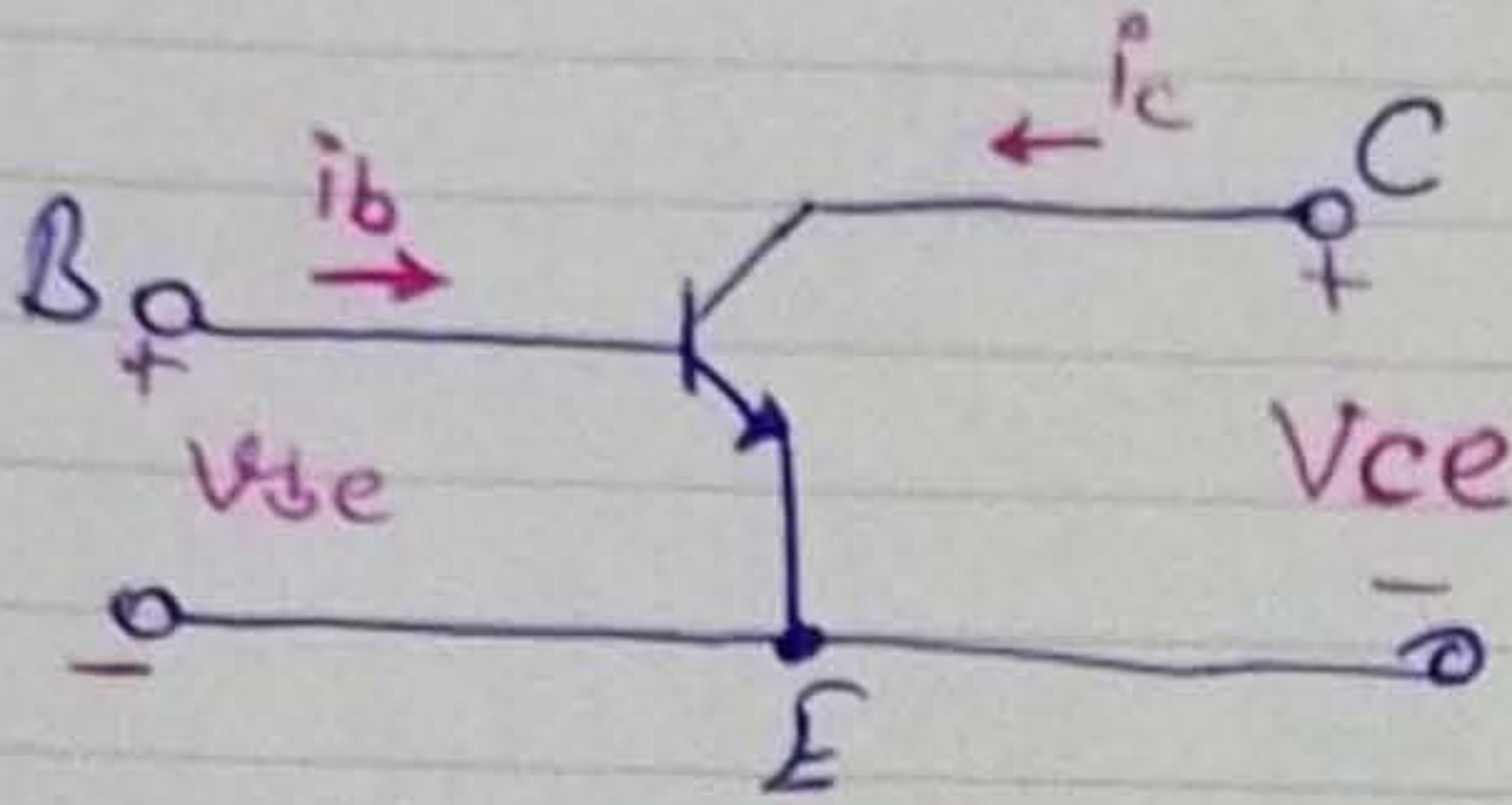


# Esdeger AC Devre Modeli

①



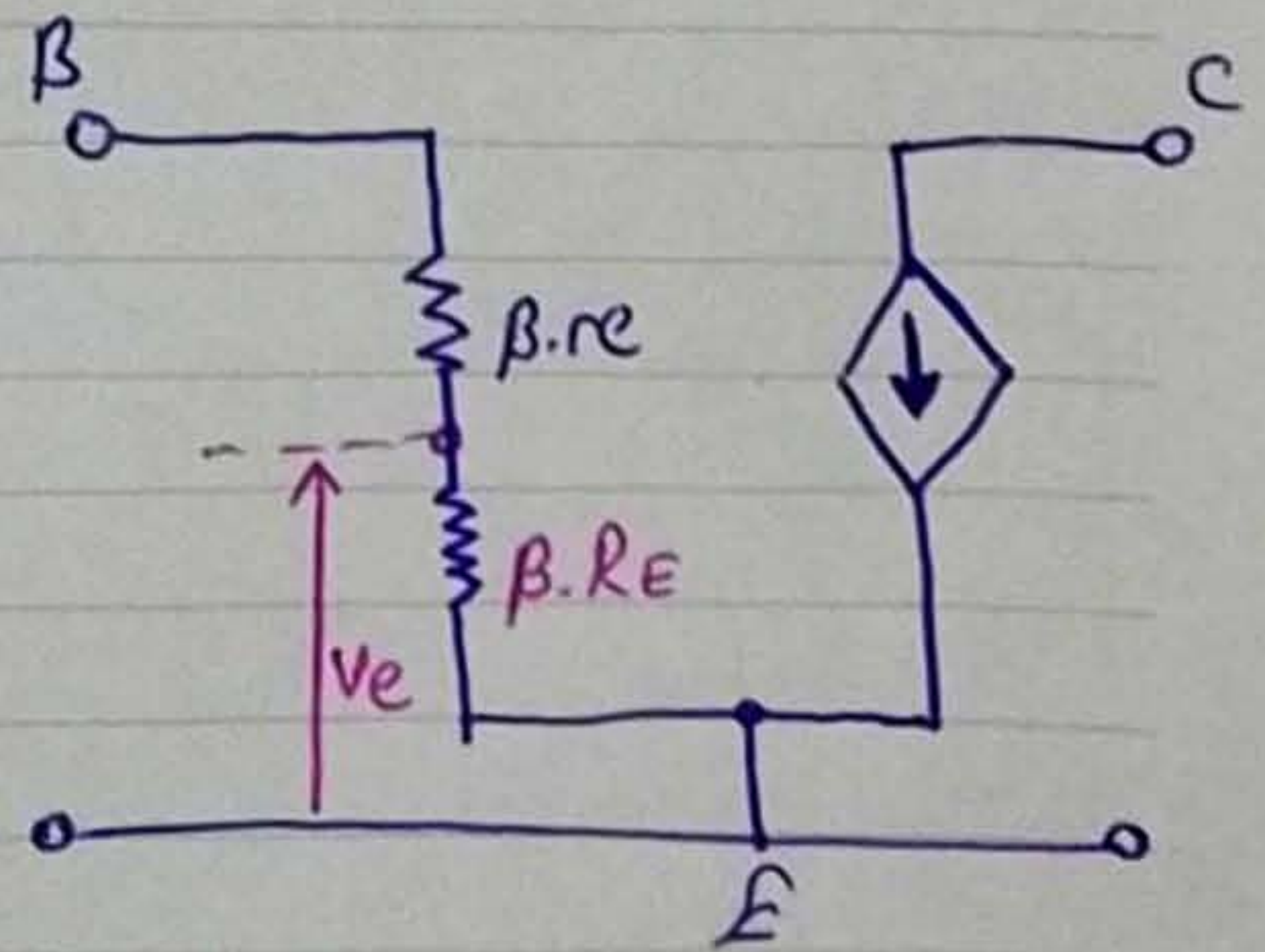
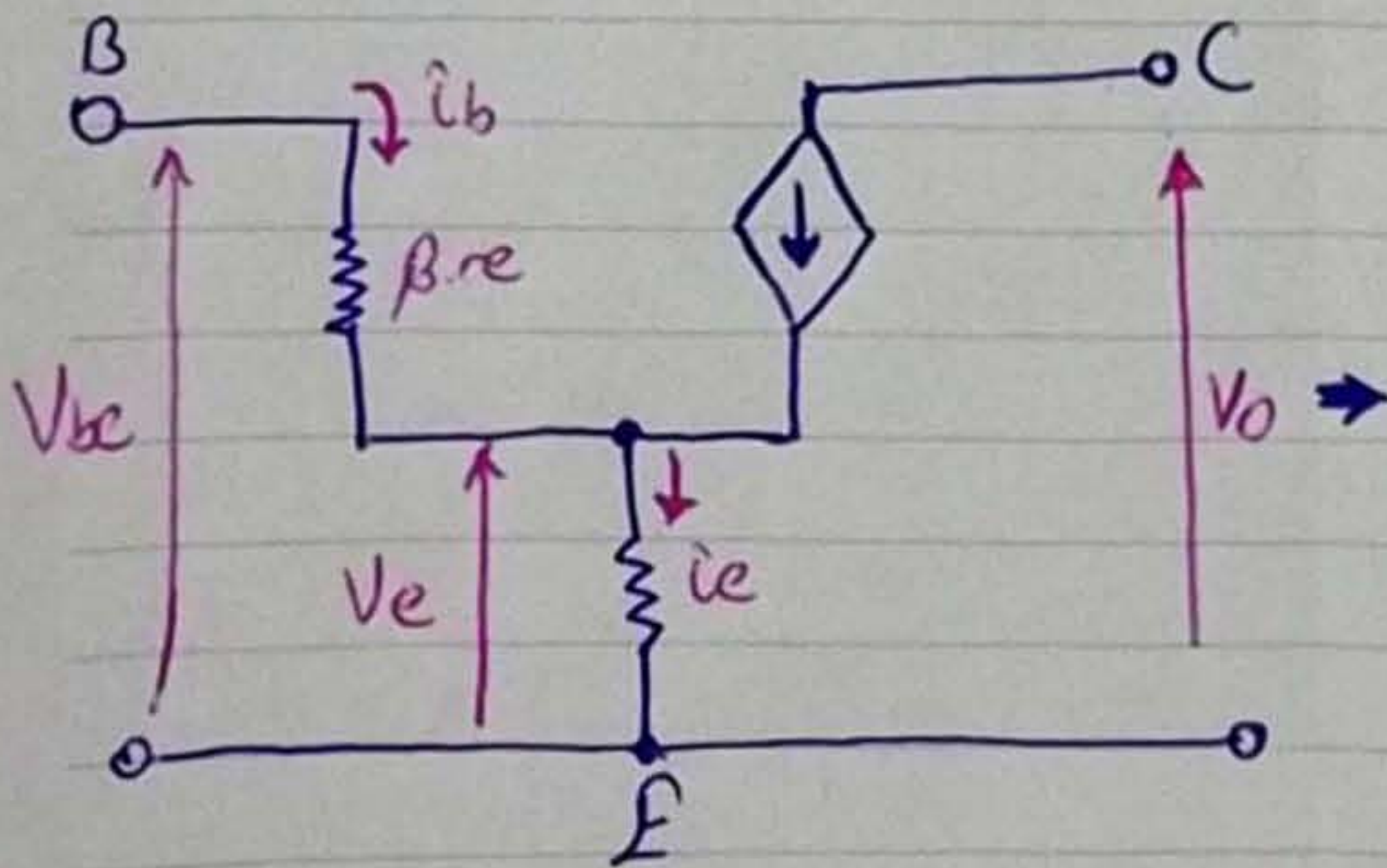
$$g_m = \frac{I_{CQ}}{V_T}$$

$$r_{\pi} \cdot g_m = \left( \frac{\beta \cdot V_T}{I_{CQ}} \right) \left( \frac{I_{CQ}}{V_T} \right) = \beta$$

$$r_e = \frac{V_{be}}{i_e} = \frac{V_T}{I_{EQ}}$$

$$r_{\pi} = (1 + \beta)r_e \Rightarrow r_{\pi} \approx \beta \cdot r_e$$

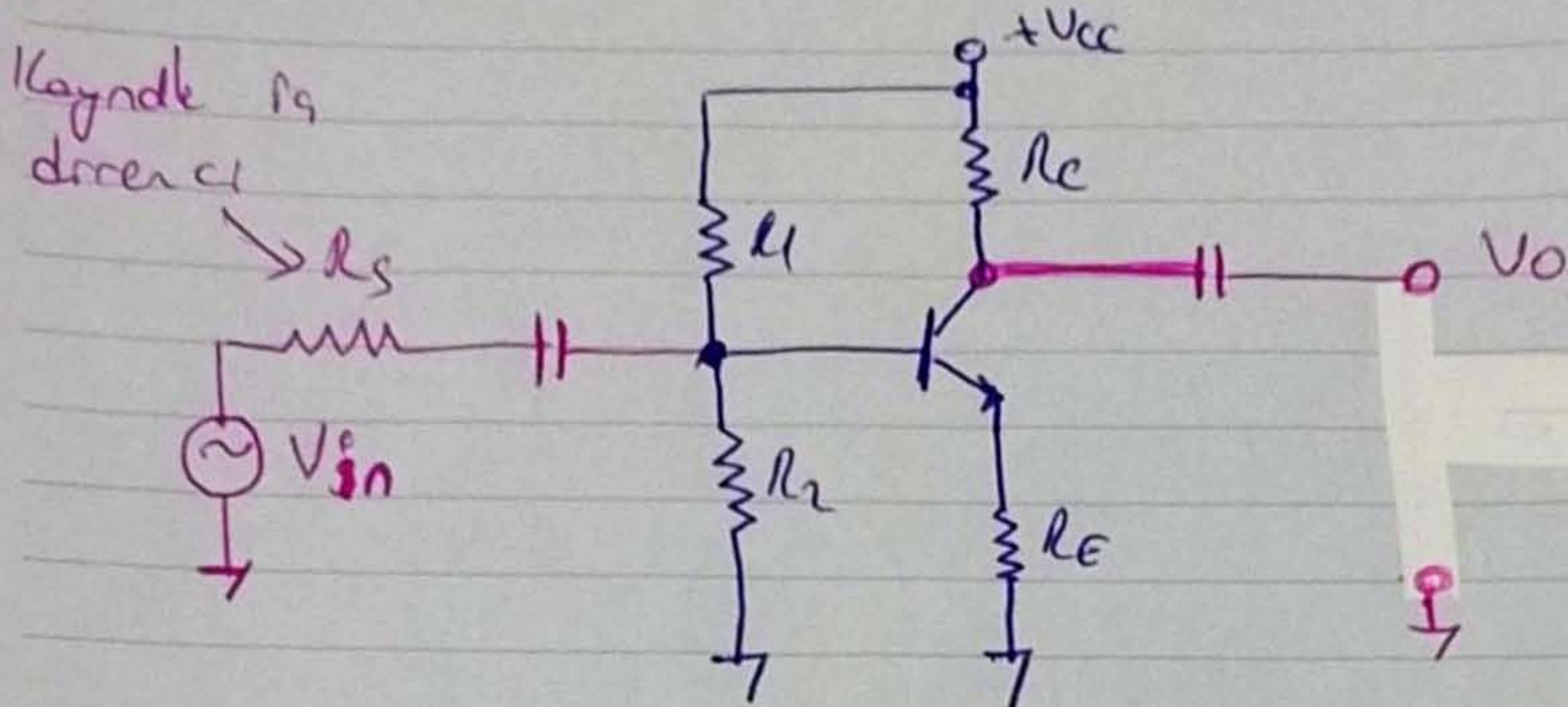
\* Özel Durum (RE varsa)



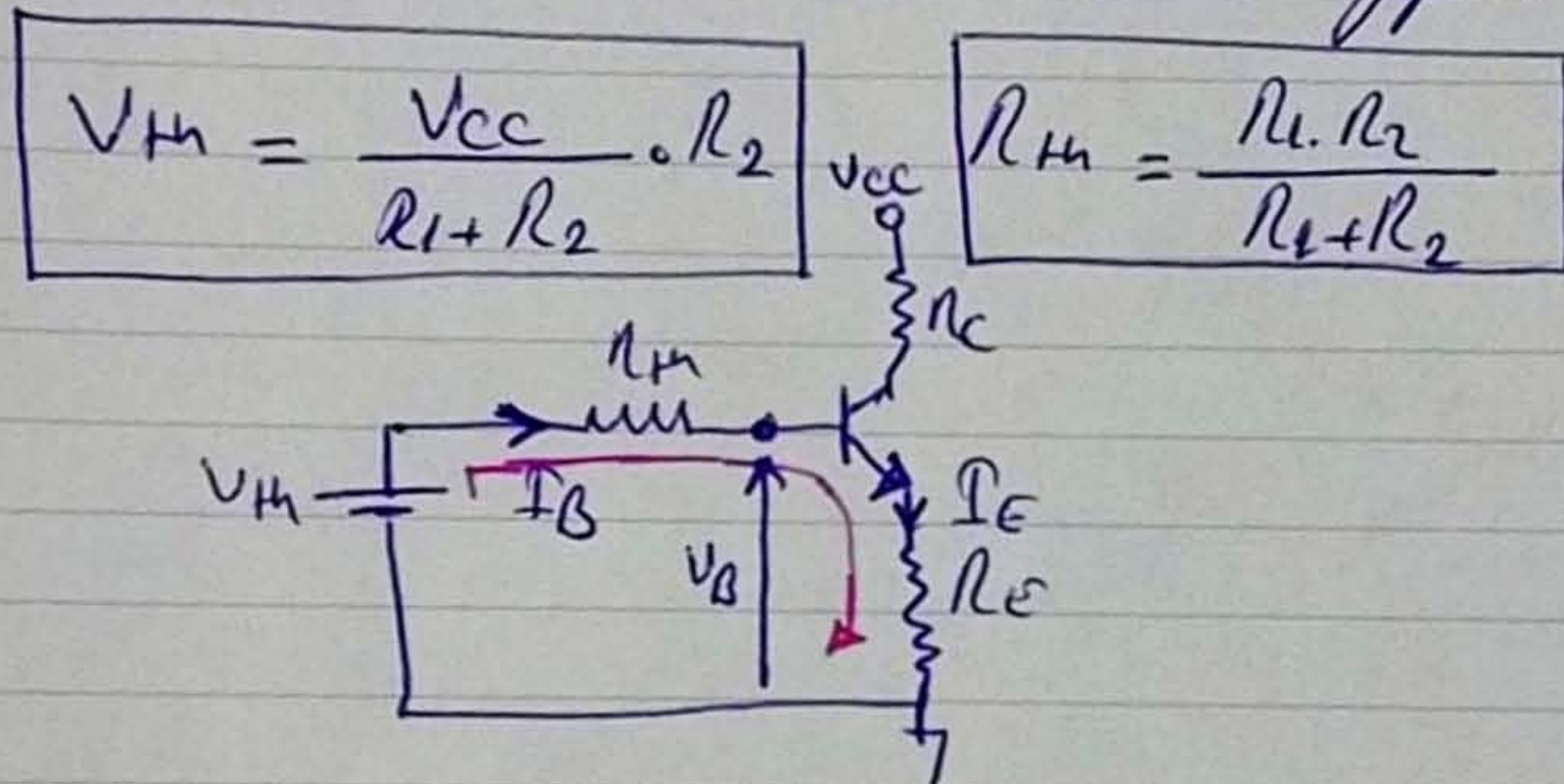


## GERİLİM BÖLÜCÜ POLARLAMA DİRENK

RS DİRENKLİ AC Analiz



\* DC analiz mor renk kısımda yapılır



①

$$V_{TH} - I_B \cdot R_{TH} - V_{BE} - I_E \cdot R_E = 0$$

$$I_B = \frac{I_E}{(\beta + 1)} \quad I_E = (\beta + 1) I_B$$

$$V_{TH} - \frac{I_E}{(\beta + 1)} \cdot R_{TH} - V_{BE} - I_E \cdot R_E = 0$$

$$I_E = \frac{V_{TH} - V_{BE}}{R_E + \left(\frac{R_{TH}}{\beta + 1}\right)} \Rightarrow I_B = \frac{I_E}{\beta + 1}, \quad I_C = \beta \cdot I_B$$

②

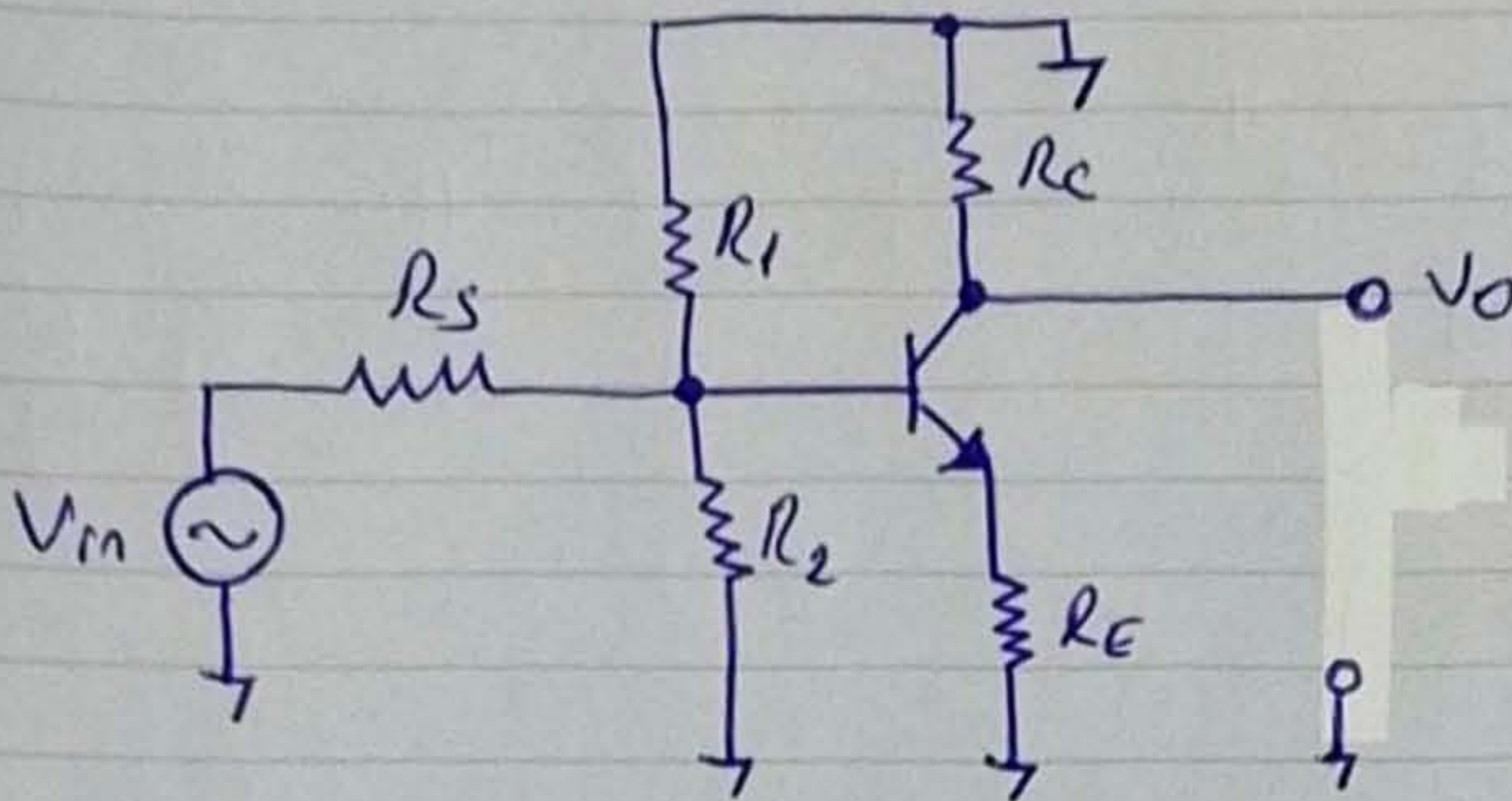
$$V_{CC} - I_C \cdot R_C - V_{CE} - I_E \cdot R_E = 0 \Rightarrow V_{CE} = V_{CC} - I_C \cdot R_C - I_E \cdot R_E$$

$V_{CC} > V_{CE} > V_{BE}$  ise  
transistor aktif bölgede



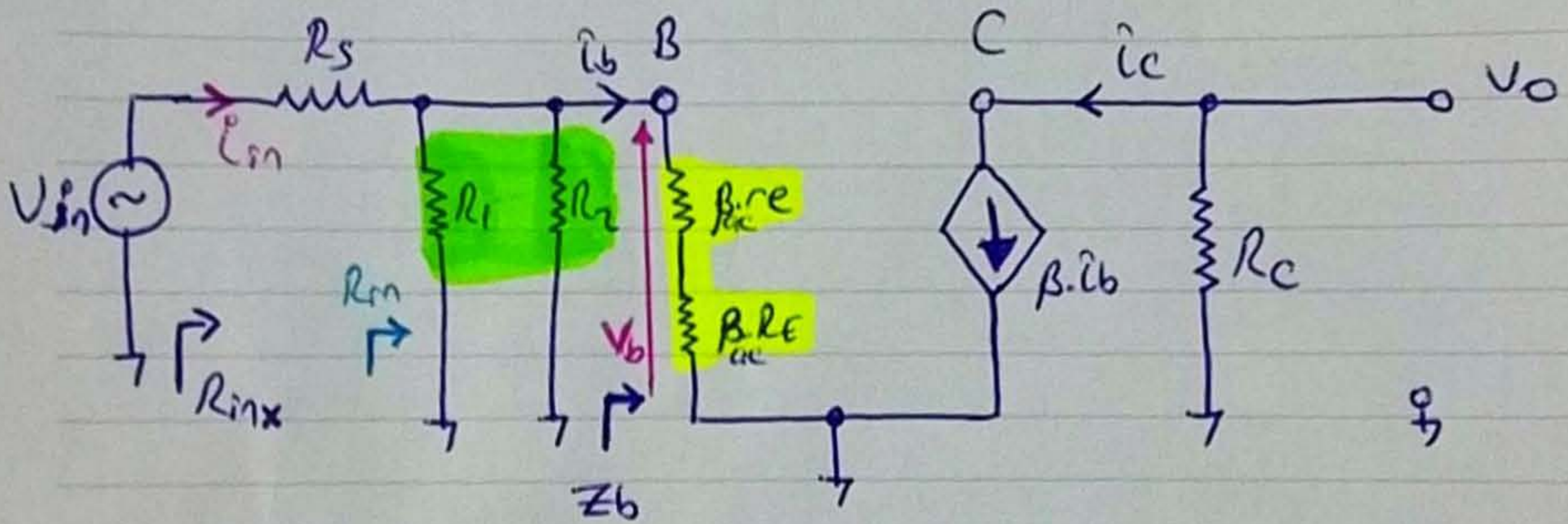
3

\* AC analizde Dc kaynaklar kısa devre, kondansatörler kısa devre yapılır. Bu durumda basit eşdeğer devre şöyle olur;



AC eşdeğer devre ise

$$* r_e = \frac{26mV}{I_E}$$



$$Z_b = r_{mb} = \beta_{ac} (r_e + R_E)$$

$$R_a = R_1 // R_2 = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

$$R_m = R_a // Z_b$$

$$R_m = \frac{R_a \cdot Z_b}{R_a + Z_b}$$

$$R_{in} = R_s + R_a // Z_b = R_s + \frac{R_a \cdot Z_b}{R_a + Z_b} \quad i_m = \frac{V_m}{R_{in}}$$

$$V_b = i_b \cdot Z_b = V_m - i_m \cdot R_s \quad V_b = V_m - \frac{V_m \cdot R_s}{R_{in}} = \left(1 - \frac{R_s}{R_{in}}\right) V_m$$

$$V_b = \left(\frac{R_{in} - R_s}{R_{in}}\right) \cdot V_m \Rightarrow V_m = \frac{V_b \cdot R_{in}}{R_{in} - R_s} \text{ olur.}$$

1 yerne  $R_{in}/R_{in}$  yerine



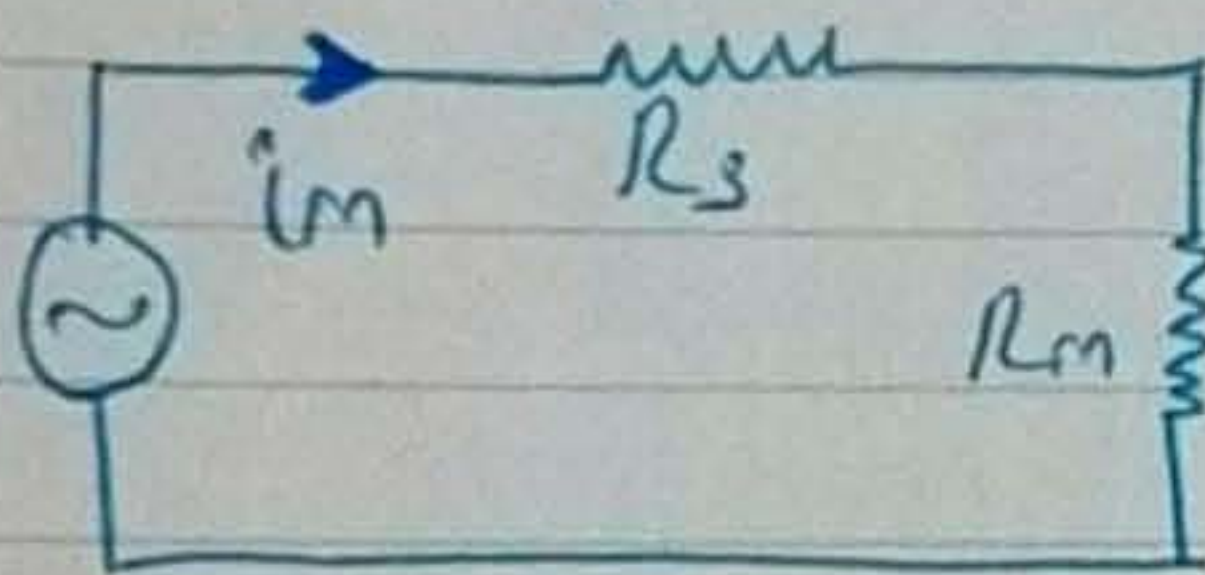
$$V_{in} = \frac{R_{mx}}{R_{mx} - R_s} \cdot (i_b \cdot Z_b) = \frac{R_{mx} \cdot Z_b}{R_{mx} - R_s} \cdot i_b \quad \text{olur,}$$

$$V_{in} = \frac{R_{mx} \cdot Z_b \cdot i_b}{R_{mx} - R_s}$$

$$V_o = -i_c \cdot R_c = -\beta_{ac} \cdot i_b \cdot R_c$$

$$A_v = \frac{-\beta_{ac} \cdot i_b \cdot R_c}{\frac{R_{mx} \cdot Z_b \cdot i_b}{(R_{mx} - R_s)}} = \boxed{-\frac{\beta_{ac} \cdot R_c \cdot (R_{mx} - R_s)}{R_{mx} \cdot Z_b}}$$

Devrenin giriş lusmini tekrar çiziyorsak



$$R_m = \frac{R_a \cdot Z_b}{R_a + Z_b}$$

$$V_b = \frac{V_m}{R_s + R_m} \cdot R_m$$

$$V_{in} = \frac{V_b \cdot (R_s + R_m)}{R_m}$$

$$Z_b \cdot i_b$$

$$\rightarrow \beta_{ac} (r_e + R_c)$$

Bu durumda

$$A_v = \frac{V_o}{V_p} = -\frac{\beta_{ac} \cdot i_b \cdot R_c}{\beta_{ac} \cdot (r_e + R_c) \cdot i_b \cdot \frac{(R_s + R_m)}{R_m}}$$

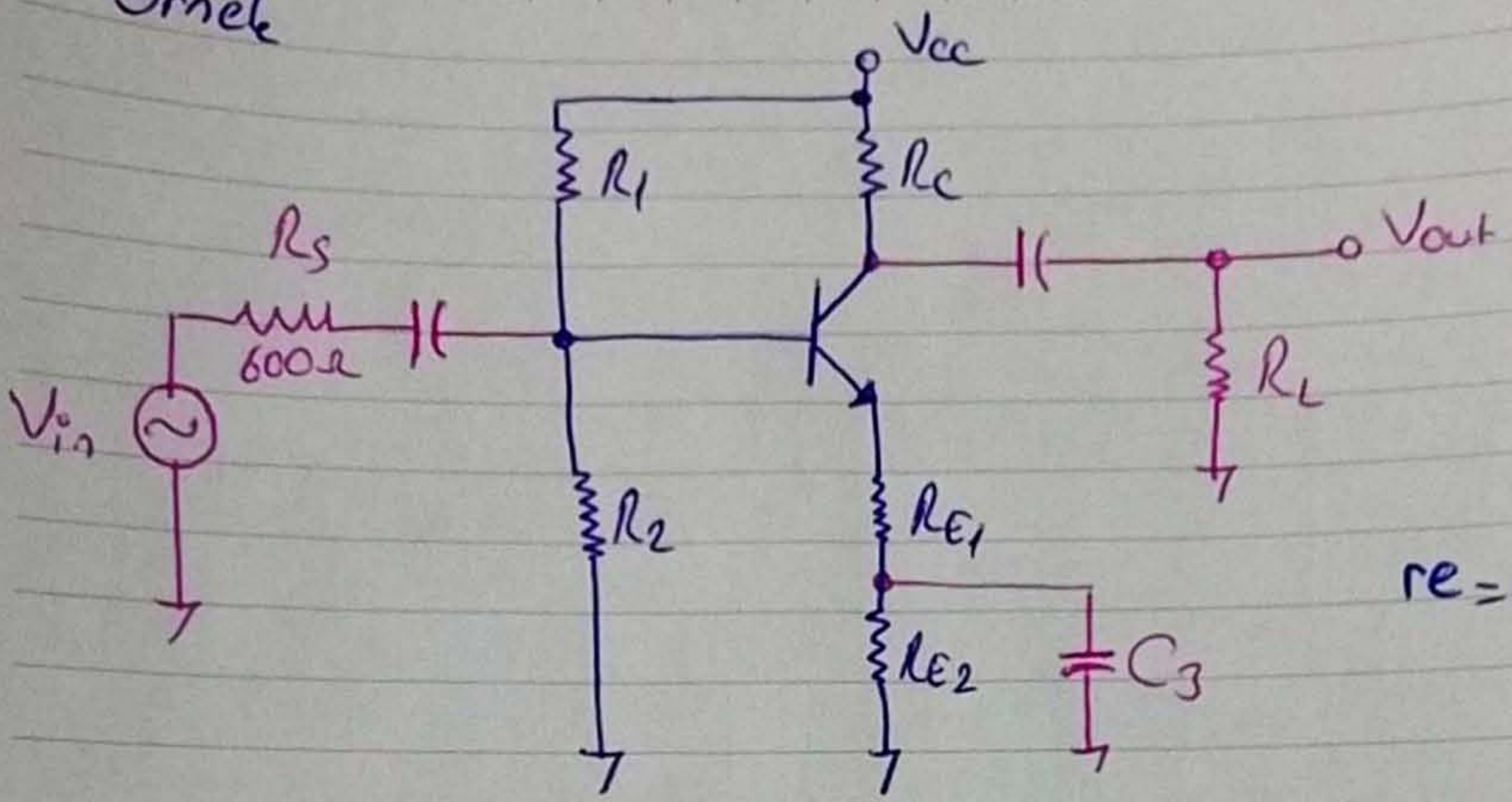
$$A_v = \boxed{-\frac{R_c \cdot R_m}{(r_e + R_c) \cdot (R_s + R_m)}} \quad \text{olur.}$$

\* Eğer emittör de kondansatör varsa  $R_c$  kısa devre olacağı için

$$A_v = \boxed{-\frac{R_c \cdot R_m}{r_e \cdot (R_s + R_m)}} \quad \text{olur.}$$



# Örnek



$$r_e = \frac{25mV}{I_E}$$

$\beta = 150$ ,  $\beta_{ac} = 175$ ,  $V_{cc} = 10V$ ,  $R_1 = 50k$ ,  $R_2 = 10k$ ,  $R_C = 5k$   
 $R_{E1} = R_{E2} = 500\Omega$ ,  $R_L = 50k$ ,  $V_m = 10mV$  ise devrenin  
 gerilim kazancını ve toplam çıkış gerilimini bulunuz.

$$V_B = \frac{V_{cc}}{R_1 + R_2} \cdot R_2 = 1,6667V$$

$$\beta(R_{E1} + R_{E2}) \gg 10R_2$$

Yaklaşık Analiz ✓

$$V_E = V_B - V_{BE} = 0,96667V$$

$$I_E = \frac{V_E}{R_{E1} + R_{E2}} = 0,9667mA$$

$$I_C = \frac{I_E}{(\beta + 1)} \cdot \beta = 0,96026mA$$

$$V_{cc} - I_C R_C - V_{CE} - I_E (R_{E1} + R_{E2}) = 0 \Rightarrow V_{CE} = 4,232V //$$

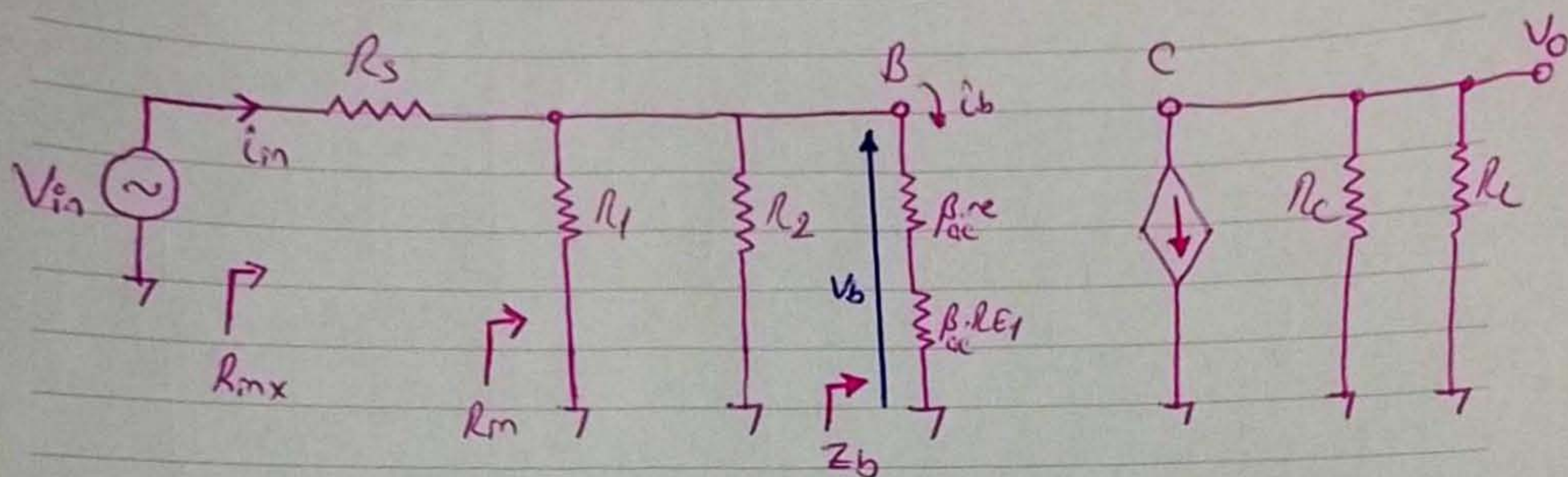
transistör aktif bölgede

$$r_e = \frac{25mV}{I_E} = 25,862 \Rightarrow \beta_{ac} R_E = \underline{\underline{4,5259k\Omega}}$$



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AC



$$Z_b = \beta_{ac} (r_e + R_{E1}) = 92,026 \text{ k}$$

$$R_{in} = R_1 \parallel R_2 \parallel Z_b \Rightarrow \frac{1}{R_{in}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{Z_b} = 7,6414 \text{ k}$$

$$R_{mx} = R_s + R_{in} = 8,2414 \text{ k}\Omega$$

$$\hat{i}_m = \frac{V_{in}}{R_{mx}} = 1,2134 \mu\text{A}$$

$$V_b = \hat{i}_m \cdot R_{in} = 9,272 \text{ mV}$$

$$\hat{i}_b = \frac{V_b}{Z_b} = 1,0075 \cdot 10^{-7} \text{ A} \Rightarrow \hat{i}_c = \beta_{ac} \cdot \hat{i}_b = 17,632 \mu\text{A}$$

$$r_c = R_c \parallel R_L \Rightarrow r_c = \frac{R_c \cdot R_L}{R_c + R_L} = 4,5455 \text{ k}\Omega$$

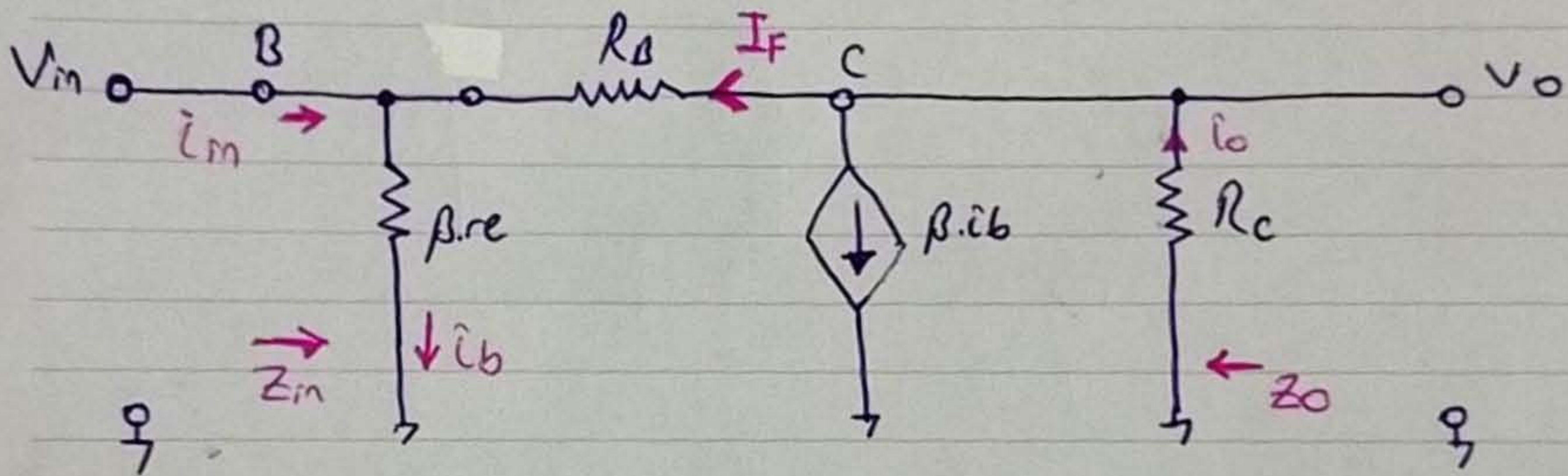
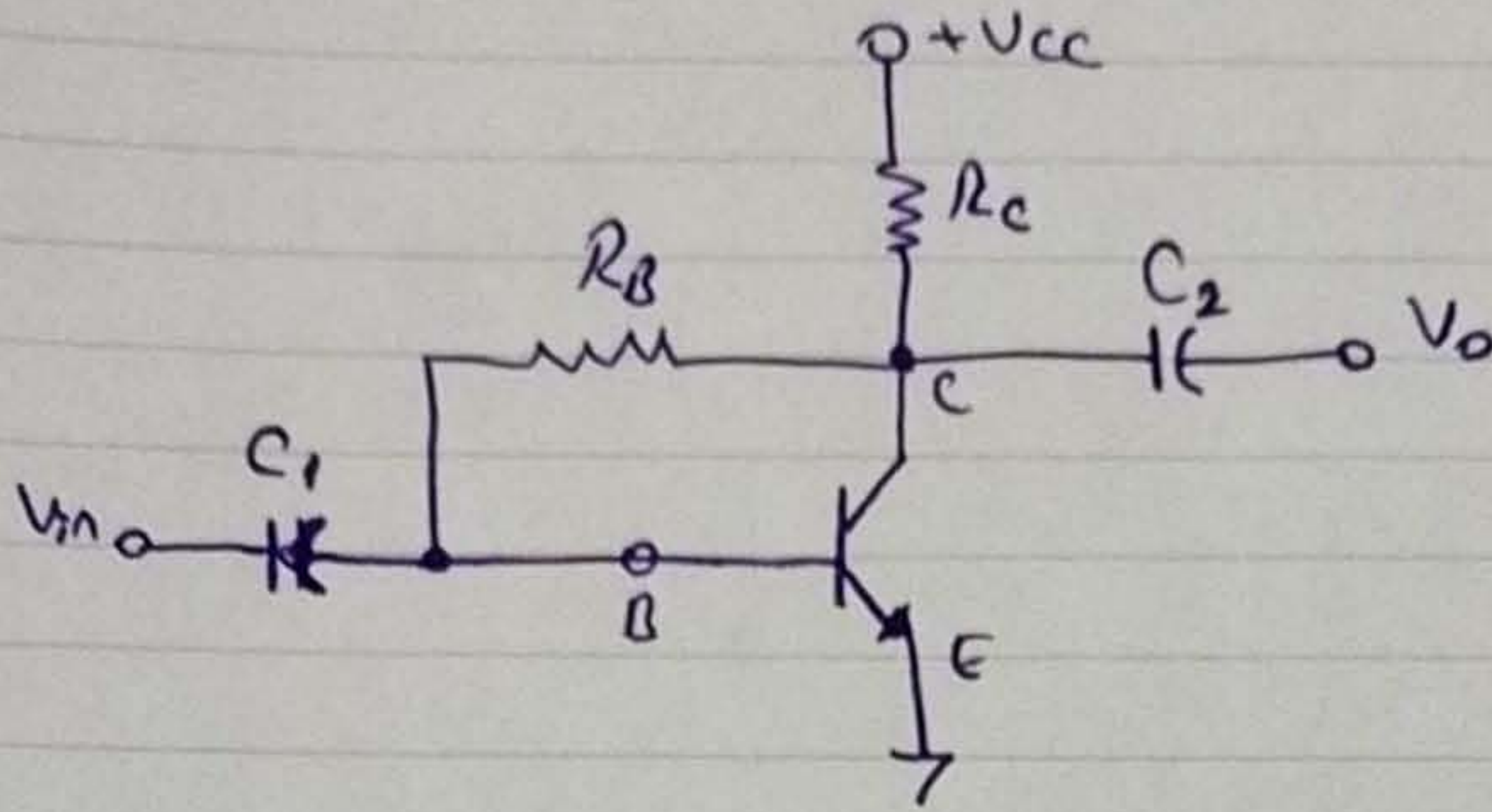
$$V_o = -\hat{i}_c \cdot r_c = -0,080145 \text{ V} = -80,145 \text{ mV}$$

$$A_v = -\frac{V_o}{V_i} = \frac{-80,145 \text{ mV}}{10 \text{ mV}} \approx -8 //$$



# Kollektör Dirençli Geri Beslemeli Yükseltkeç

7



$$① \quad I_f = \frac{V_o - V_i}{R_B} = \frac{I_o R_C - \beta r_e I_b}{R_B}$$

$$I_o = \beta I_b + I_f \quad \beta I_b \gg I_f \text{ olduğundan } I_o \approx \beta I_b$$

$$\text{Bu durumda } V_o = \beta I_b R_C = -\beta \left( \frac{V_{in}}{\beta r_e} \right) R_C$$

$$② \quad \boxed{V_o = -\frac{R_C}{r_e} \cdot V_{in}} \quad I_b = I_m + I_f \Rightarrow \text{2'yi 1'de yerine yazarsak}$$

$$I_f = I_b - I_m = -\frac{R_C}{r_e R_B} \cdot V_m - \frac{V_m}{R_B} =$$

$$I_m = \left( \frac{V_m}{\beta r_e} \right) + \left( 1 + \frac{R_C}{r_e} \right) \cdot \frac{V_m}{R_B} \rightarrow -I_f \quad * V_m \text{ ortak paranteze alınsak}$$

$$I_m = V_m \left[ \frac{1}{\beta r_e} + \left( 1 + \frac{R_C}{r_e} \right) \frac{1}{R_B} \right] \text{ alın}$$



$$Z_{in} = \frac{V_{in}}{i_{in}} = \frac{V_{in}}{V_{in} \left[ \frac{1}{\beta r_e} + \left(1 + \frac{R_c}{r_e}\right) \cdot \left(\frac{1}{R_B}\right) \right]}$$

Var'ları sadeleştir

Payı ve paydağı  $\beta r_e$  ile çarpalım

$$Z_{in} = \frac{\beta r_e}{\beta r_e \left[ \frac{1}{\beta r_e} + \left(1 + \frac{R_c}{r_e}\right) \cdot \left(\frac{1}{R_B}\right) \right]}$$

$\beta r_e$  ile çarpalım

$$Z_{in} = \frac{\beta r_e}{1 + \frac{\beta r_e}{R_B} \cdot \left(1 + \frac{R_c}{r_e}\right)}$$

$\frac{R_c}{r_e} \gg 1$  ise

$$Z_{in} = \frac{r_e}{\frac{1}{\beta} + \frac{R_c}{R_B}} \quad \text{olur}$$

$$Z_o \cong R_c // R_B$$