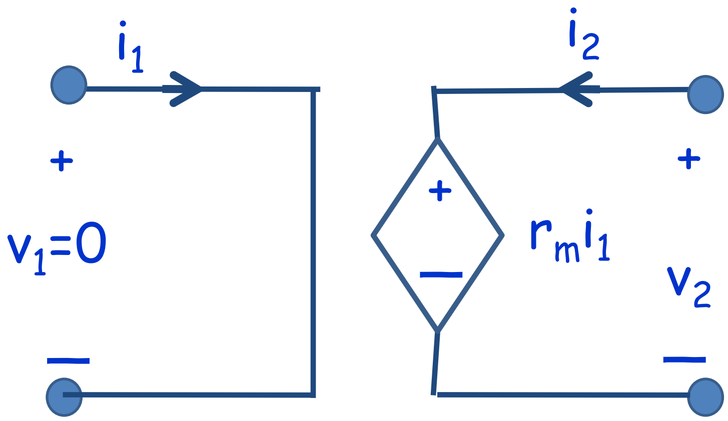
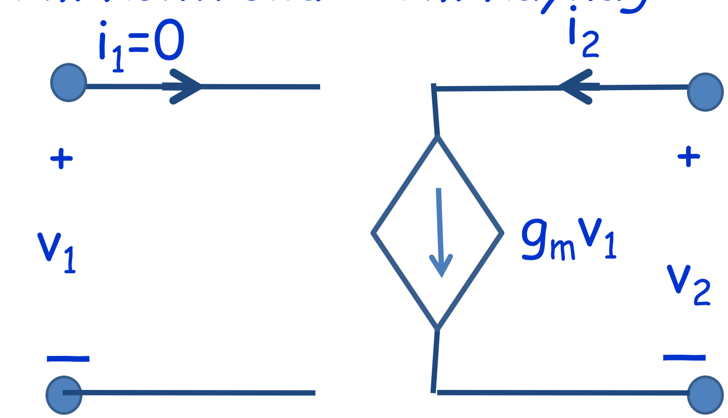
Bazı Lineer 2-kapılı Direnç Elemanları

Akım Kontrollü Gerilim Kaynağı



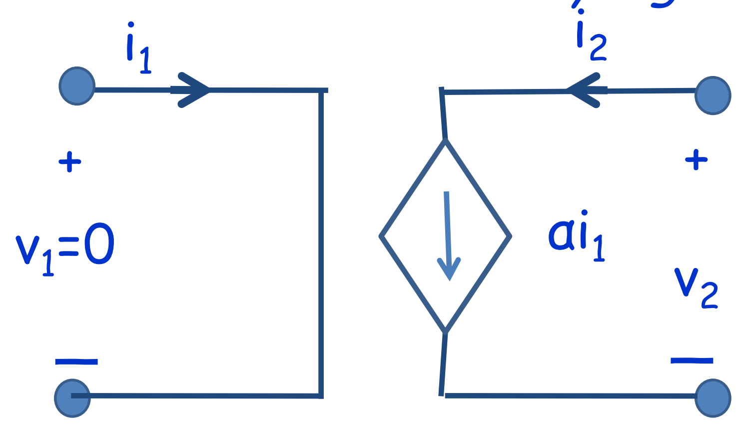
$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ r_m & 0 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$$

Gerilim Kontrollü Akım Kaynağı



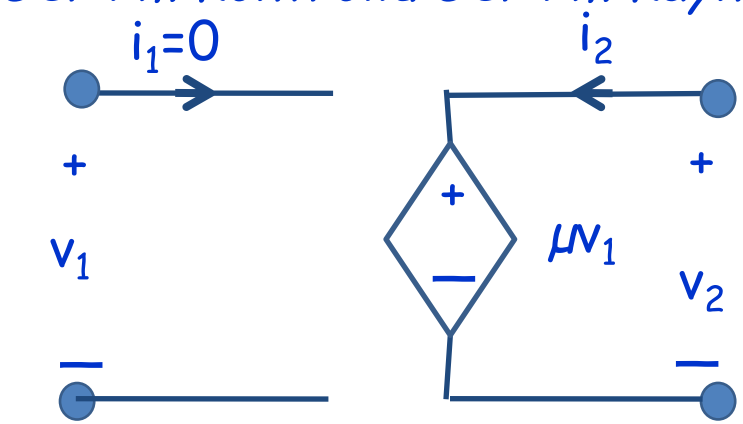
$$\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ g_m & 0 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

Akım Kontrollü Akım Kaynağı



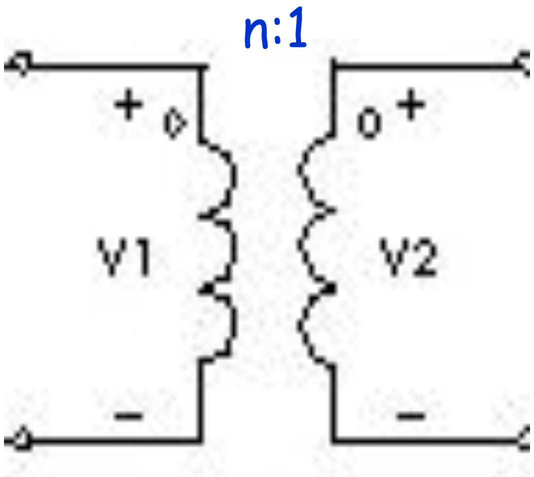
$$\begin{bmatrix} v_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ \alpha & 0 \end{bmatrix} \begin{bmatrix} i_1 \\ v_2 \end{bmatrix}$$

Gerilim Kontrollü Gerilim Kaynağı



$$\begin{bmatrix} i_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ \mu & 0 \end{bmatrix} \begin{bmatrix} v_1 \\ i_2 \end{bmatrix}$$

İdeal Transformatör

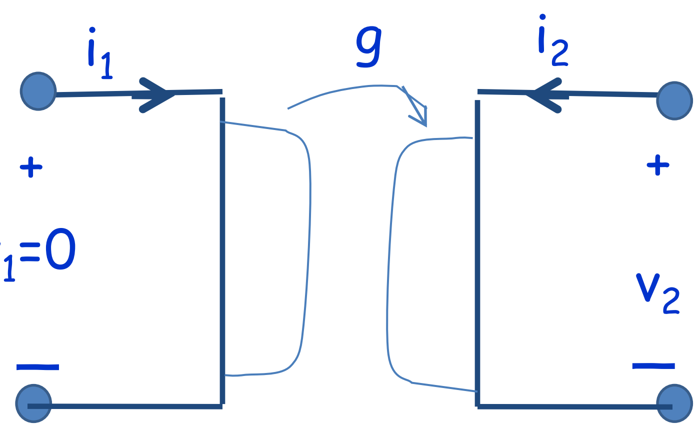


http://www.ece.uci.edu/docs/hspice/hspice_2001_2-2497.jpg

$$\begin{bmatrix} v_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 0 & n \\ -n & 0 \end{bmatrix} \begin{bmatrix} i_1 \\ v_2 \end{bmatrix}$$

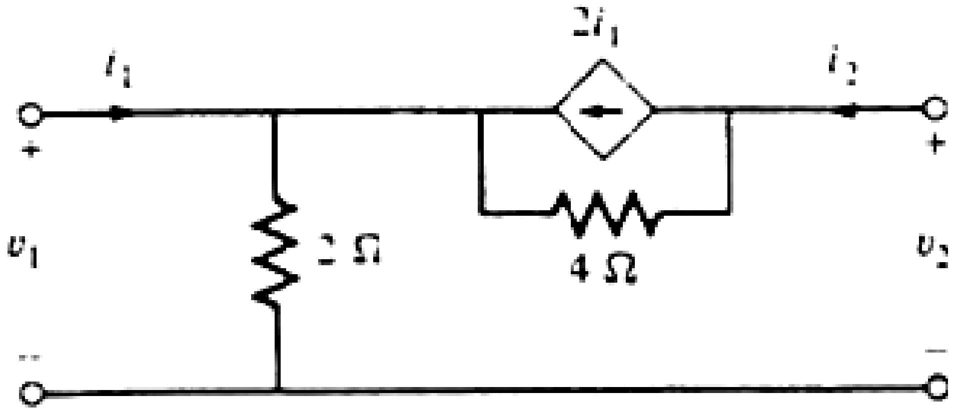
$$\begin{aligned} p(t) &= v_1(t)i_1(t) + v_2(t)i_2(t) \\ &= v_1(t)i_1(t) - \frac{1}{n} v_1(t) n i_1(t) \\ &= 0 \end{aligned}$$

Jiratör



$$\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 0 & G \\ -G & 0 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

Şekildeki 2-kapılının tanım bağıntısını belirleyiniz



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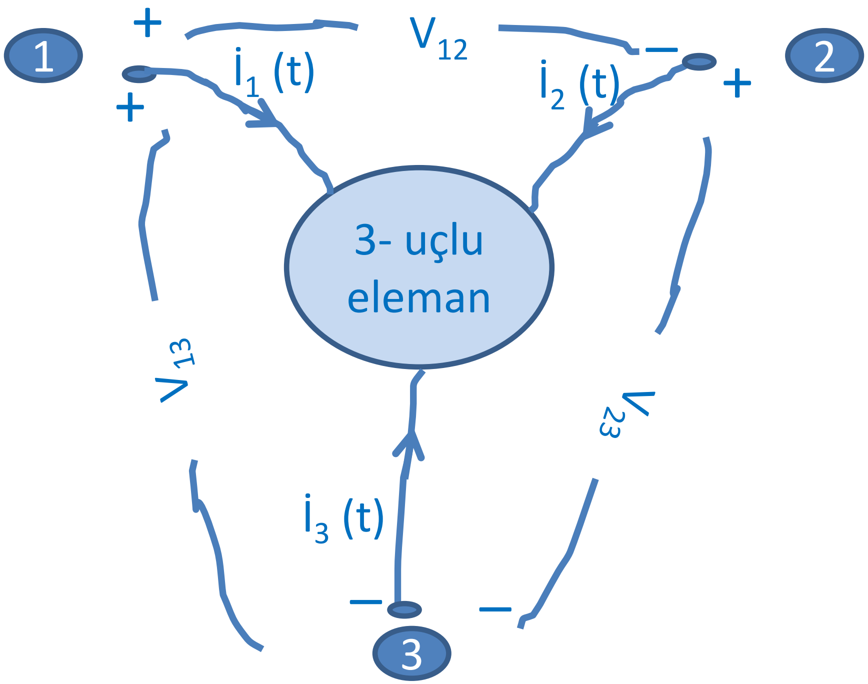
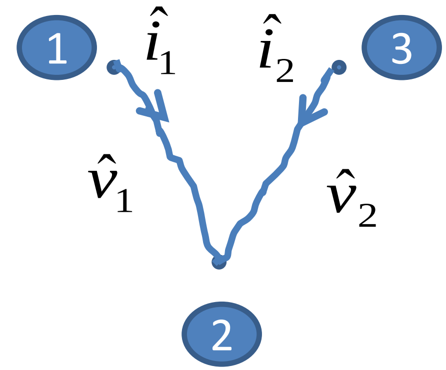


(a)



(b)

Şekil (a) daki 3-uçlu elemanın tanım bağıntısını aşağıda verilmiştir:

$$v_{13} - 2i_1 + 3v_{23} = 0$$

$$4i_1 - i_2 = 0$$

a) Şekil (b)'deki uç grafta işaretlenen akım ve gerilimler cinsinden 3-uçlu elemanın tanım bağıntısını bulunuz.

b) Sadece 2-uçlu dirençler ve bağımlı kaynaklar kullanarak verilen tanım bağıntısına sahip bir 3-uçlu çiziniz.

Lineer olmayan 2-kapılı Direnç Elemanları

$$R_R = \{(v_1, v_2, i_1, i_2) : f_1(v_1, v_2, i_1, i_2) = 0,\ f_2(v_1, v_2, i_1, i_2) = 0\}$$

Lineer dirençler için

$$f_1(v_1, v_2, i_1, i_2) = \alpha_{11} v_1 + \alpha_{12} v_2 + \alpha_{13} i_1 + \alpha_{14} i_2 = 0$$

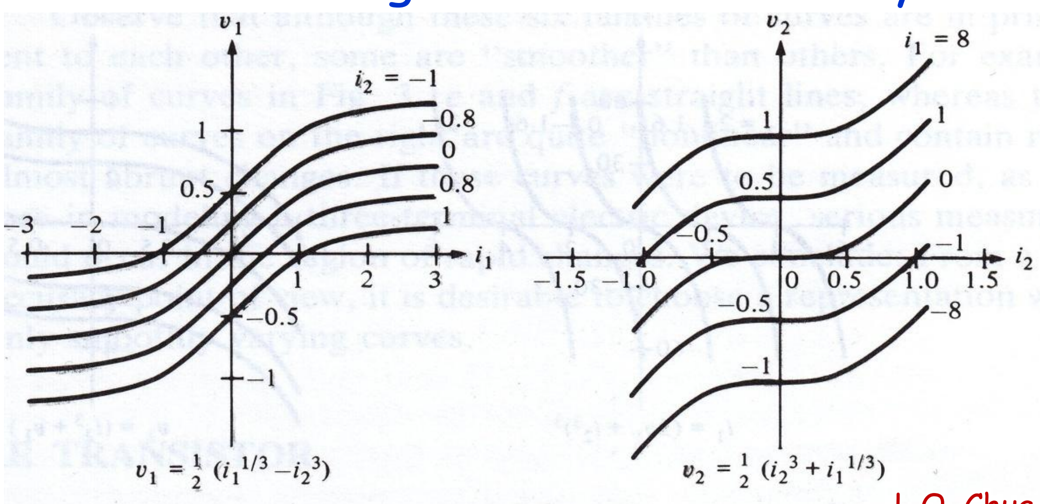
$$f_2(v_1, v_2, i_1, i_2) = \alpha_{21} v_1 + \alpha_{22} v_2 + \alpha_{23} i_1 + \alpha_{24} i_2 = 0$$

Lineer olmayanlar için bir örnek

$$f_1(v_1, v_2, i_1, i_2) = i_1 + 2i_2 - (v_1 + v_2)^3 - 2(v_2 - v_1)^{1/3} = 0$$

$$f_2(v_1, v_2, i_1, i_2) = 2i_1 - i_2 - 2(v_1 + v_2)^3 + (v_2 - v_1)^{1/3} = 0$$

6 gösterim lineer olmayanlar için nasıl belirlenir



(a)

Akım kontrollü

$$v_1 = \hat{v}_1(i_1, i_2)$$

$$v_2 = \hat{v}_2(i_1, i_2)$$

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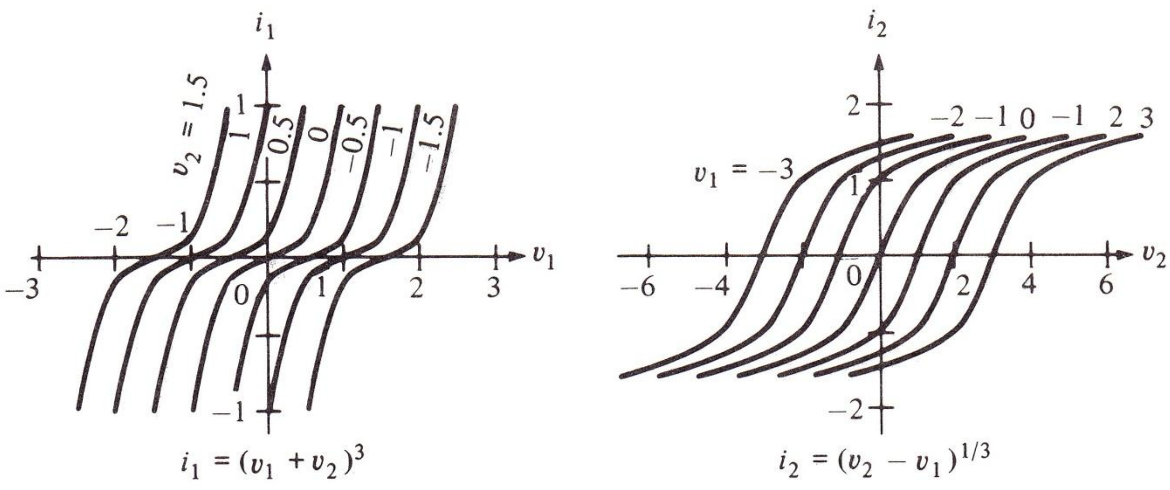
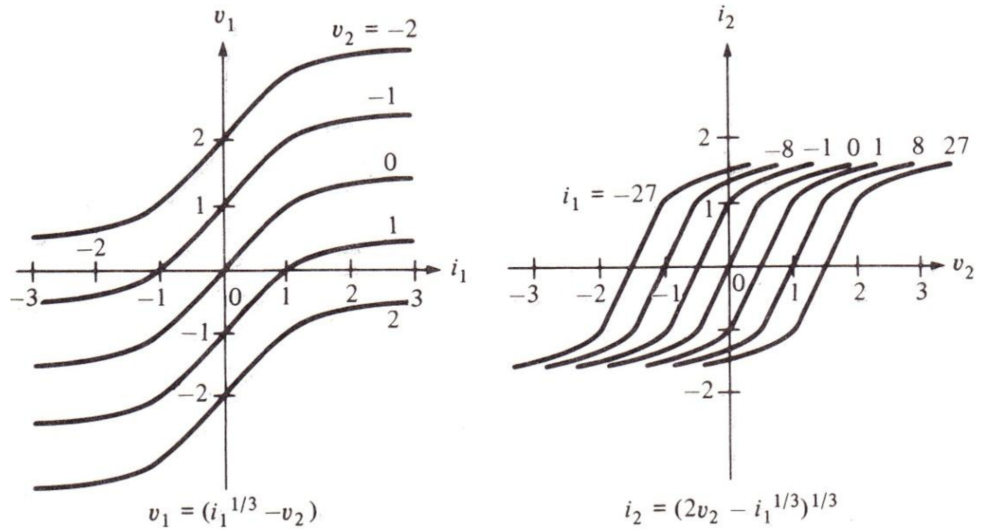


(b)

Gerilim kontrollü

$$i_1 = \hat{i}_1(v_1, v_2)$$
$$i_2 = \hat{i}_2(v_1, v_2)$$



(c)

Hibrit1

$$v_1 = \hat{v}_1(i_1, v_2)$$
$$i_2 = \hat{i}_2(i_1, v_2)$$

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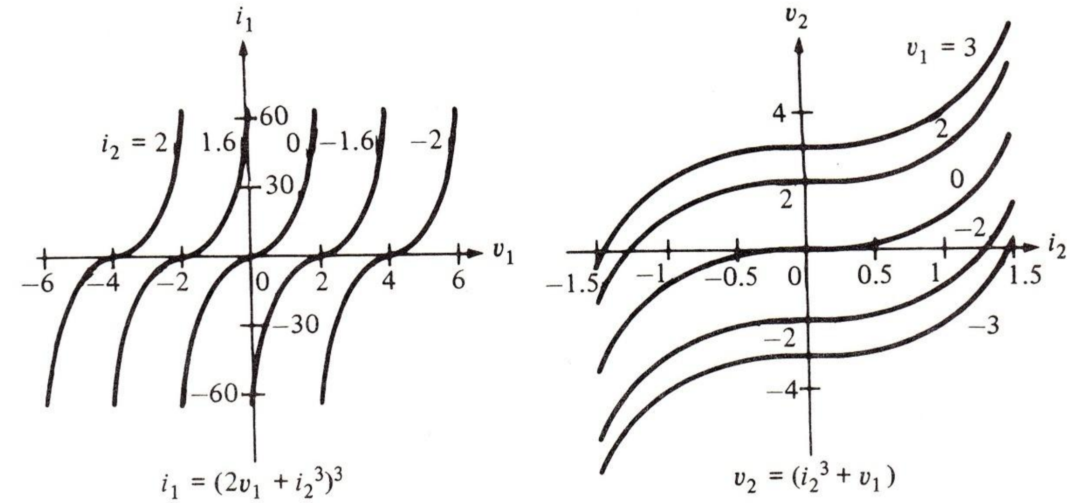
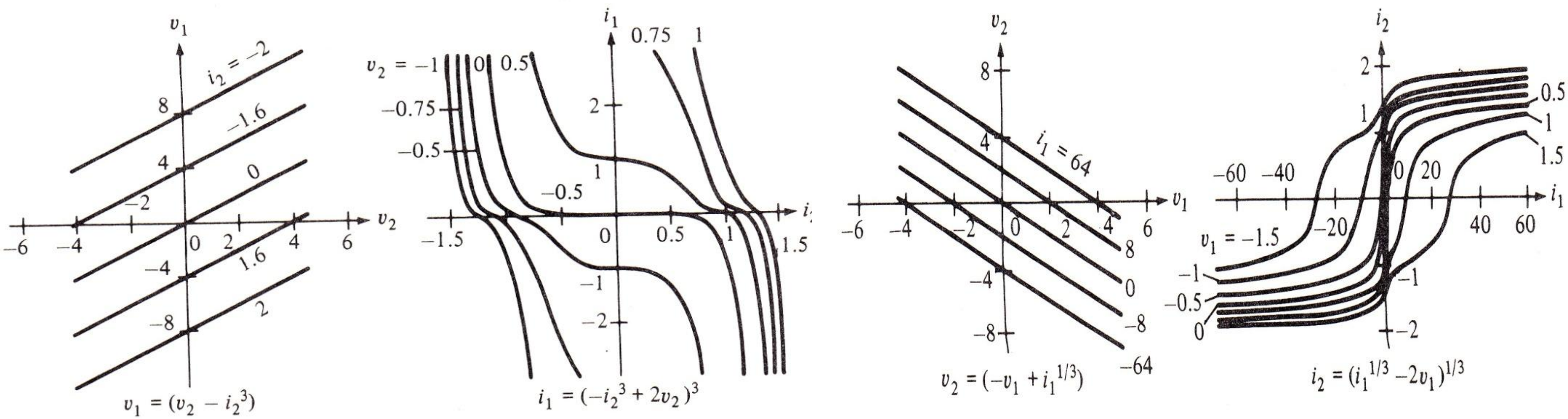


(d)

Hibrit2

$$i_1 = \hat{i}_1(v_1, i_2)$$
$$v_2 = \hat{v}_2(v_1, i_2)$$



(f)

Transmisyon 1

Transmisyon 2

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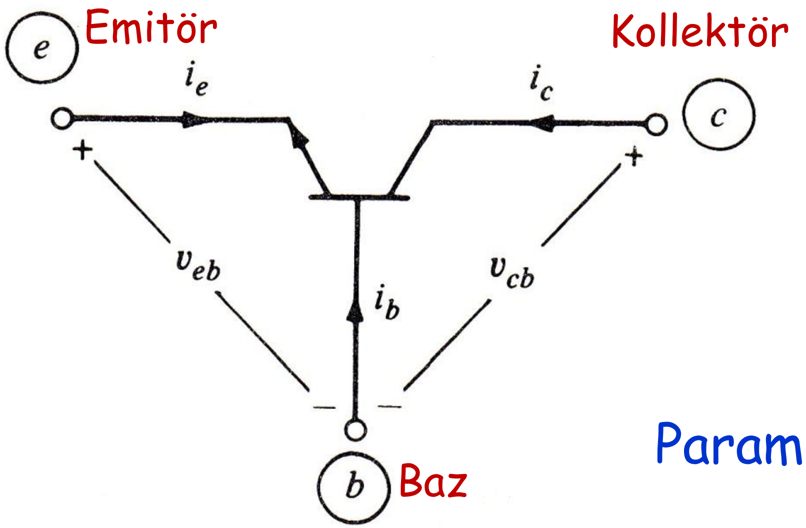
npn Bipolar Tranzistör



Alçak Frekanslardaki Eşdeğeri

Ebers-Moll Denklemleri

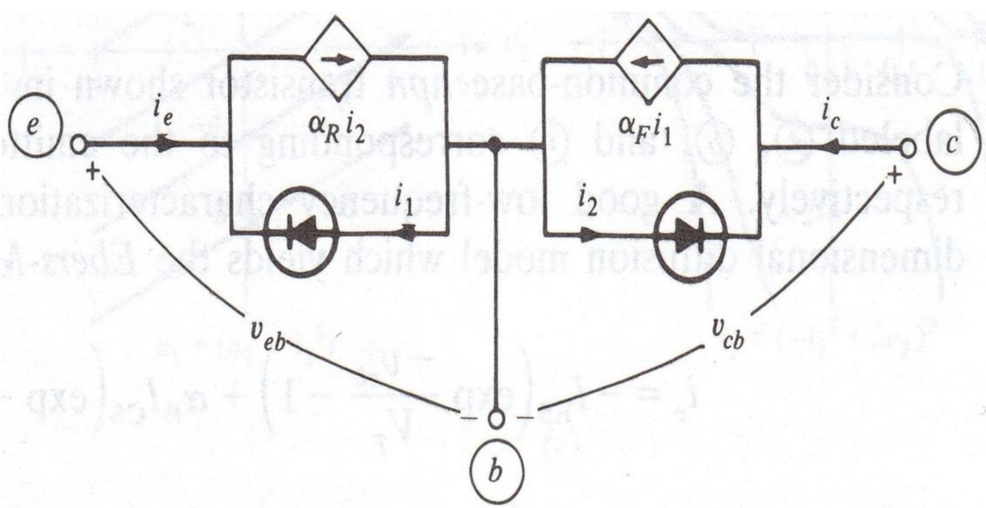
$$\begin{cases} i_e = -I_{ES} e^{-\frac{v_{eb}}{v_T}-1} + \alpha_R I_{CS} e^{-\frac{v_{cb}}{v_T}-1} \\ i_c = \alpha_F I_{ES} e^{-\frac{v_{eb}}{v_T}-1} - I_{CS} e^{-\frac{v_{cb}}{v_T}-1} \end{cases}$$

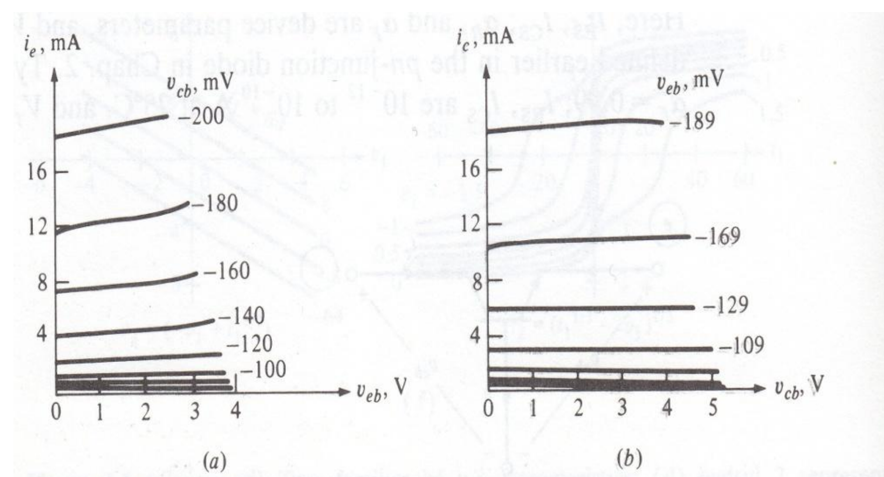
Parametreler: $I_{ES}, I_{CS}, \alpha_F, \alpha_R, V_T$

$$I_{ES}, I_{CS} \;\; 10^{-12} - 10^{-10} A, \;\; \alpha_F = 0.99, \;\; \alpha_R \;\; 0.5 - 0.8, \;\; V_T \cong 25mV \;\; (25^\circ C)$$

Ebers-Moll Denklemleri ile verilen tranzistör nasıl bir eleman?

3-uçlu, gerilim kontrollü





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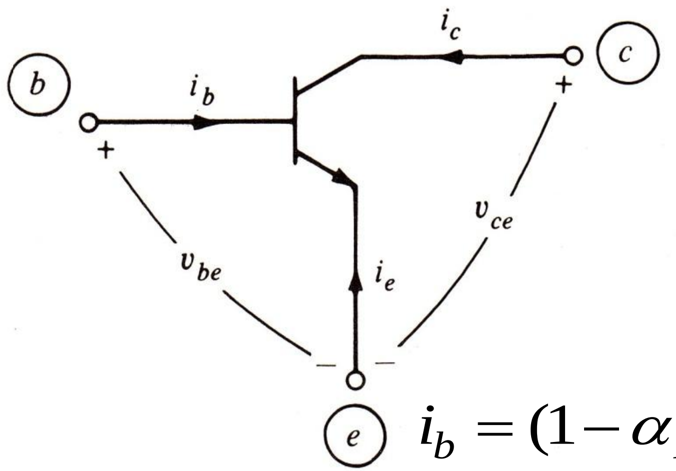
3-uçlu elemanın referansını baz yerine emitör olarak alırsak...

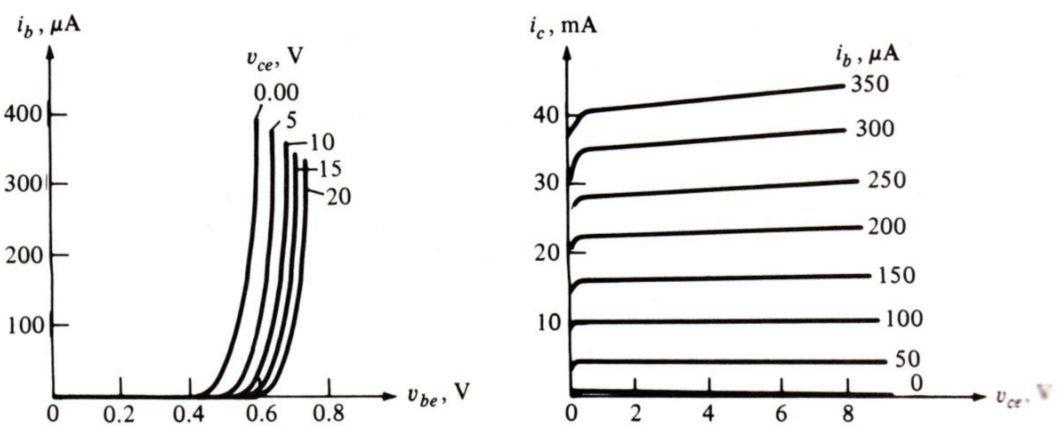


$$\left.\begin{aligned} v_{be} &= -v_{eb} \\ v_{ce} &= v_{cb} - v_{eb} \\ i_b &= -(i_e + i_c) \end{aligned}\right\}$$

Ebers-Moll denklemlerine yerleştir

$$i_b = (1-\alpha_F)I_{ES}e^{\frac{v_{be}}{v_T}-1} + (1-\alpha_R)I_{CS}e^{\frac{v_{be}-v_{ce}}{v_T}-1}$$

$$i_c = \alpha_F I_{ES}e^{\frac{v_{be}}{v_T}-1} - I_{CS}e^{\frac{v_{be}-v_{ce}}{v_T}-1}$$



(a) (b)

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For many large-signal applications, e.g., digital circuits, these models are unnecessarily complicated and further simplifications are possible. In some approximate dc analysis, it suffices to represent the base emitter by a constant voltage source E_0 in series with an ideal diode and to represent the collector emitter by a CCCS together with an ideal diode as shown in Fig. 4.8; the corresponding characteristics are shown in Fig. 4.9. For silicon transistors at room temperature, the value of E_0 is usually between 0.6 and 0.7 V.

It is important to bear in mind that models are developed with specific applications in mind. Obviously, the simpler the model, the easier the circuit analysis. Thus, for some applications, if only an approximate solution is called for, we should use the simplest but valid model to get an idea of how the circuit functions. In other situations, e.g., in determining the precise operating points using a computer, we need to use a more precise model for the transistor than that of the Ebers-Moll model. Some complicated models have been developed using a combination of physical principles and experimental measurements (e.g., the Gummel-Poon model[3]). In small-signal analysis, we use a linear model which holds only approximately in the neighborhood of the operating point. Some of these will be discussed in the remaining portions of this section.

L.O. Chua, C.A. Desoer, S.E. Kuh. "Linear and Nonlinear Circuits" Mc.Graw Hill, 1987, New York