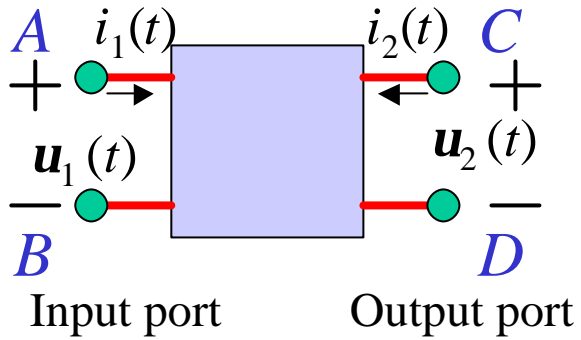


0.5 雙埠模型與理想放大器



變數 (i_1, u_1) 與 (i_2, u_2)

有源線性雙埠模型的特性

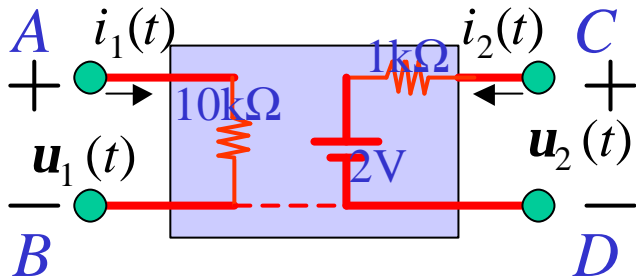
$$\begin{pmatrix} i_1 \\ i_2 \end{pmatrix} = \begin{pmatrix} ? & ? \\ ? & ? \end{pmatrix} \begin{pmatrix} u_1 \\ u_2 \end{pmatrix} + \begin{pmatrix} I_1 \\ I_2 \end{pmatrix}$$

$$\begin{pmatrix} i_2 \\ u_2 \end{pmatrix} = \begin{pmatrix} ? & ? \\ ? & ? \end{pmatrix} \begin{pmatrix} i_1 \\ u_1 \end{pmatrix} + \begin{pmatrix} I_2 \\ V_2 \end{pmatrix}$$

⋮

6種可能性

例題



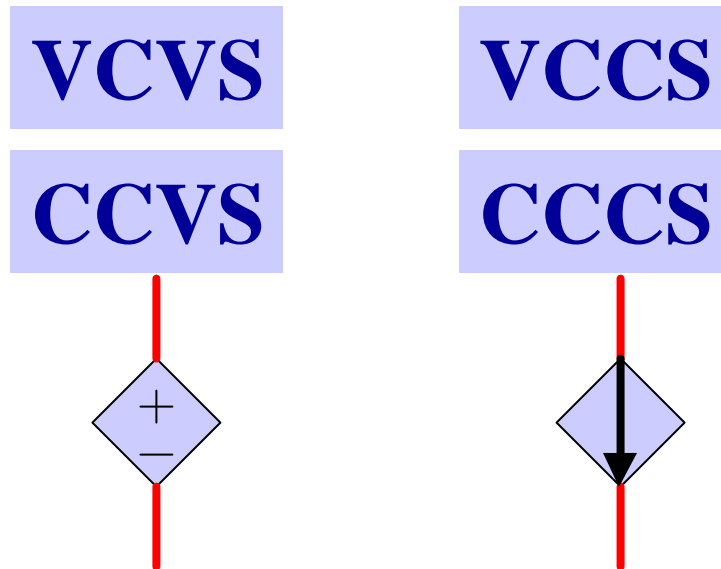
$$u_1 = i_1 \cdot 10\text{k}\Omega$$

$$u_2 = i_1 \cdot 10\text{k}\Omega + 2\text{V}$$

相依電源(dependent source)與理想放大器

相依電源(dependent source) (非獨立源) 有四種，對應四種理想放大器。

$\left\{ \begin{array}{l} \text{Voltage} \\ \text{Current} \end{array} \right\}$ - Controlled $\left\{ \begin{array}{l} \text{Voltage} \\ \text{Current} \end{array} \right\}$ Source



Types of Gains and Amplifiers

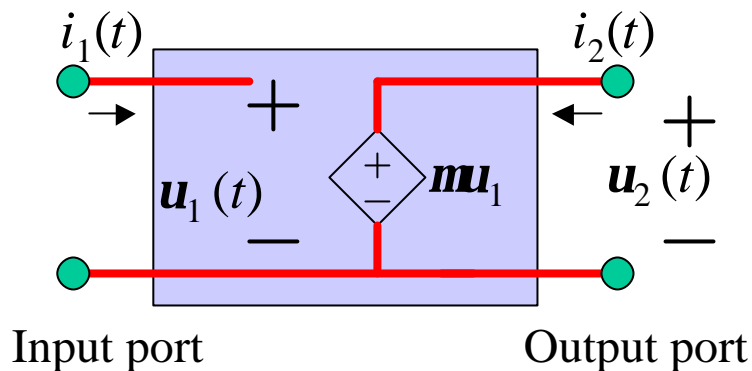
$$\text{Output} = \# \cdot \text{Input}$$

#: transmittance

	Output	Input	Transmittance [unit]	Type of Amp.
VCVS	V	V	Voltage gain $\mu[1]$	Voltage Amp.
CCCS	I	I	Current gain $\beta[1]$	Current Amp.
VCCS	I	V	transconductance $g_m[\Omega^{-1}]$	Transconductance Amp.
CCVS	V	I	transresistance $r_m[\Omega]$	Transresistance Amp.

VCVS Voltage-Controlled Voltage Source

Voltage Amplifier



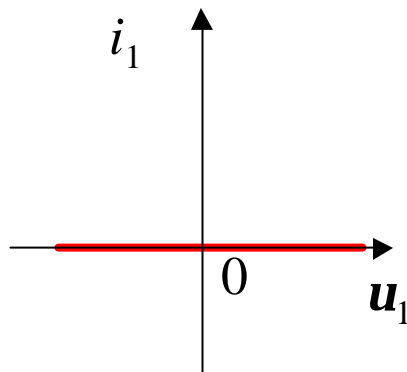
$$i_1 = 0$$

$$u_2 = m u_1$$

m voltage gain 電壓增益

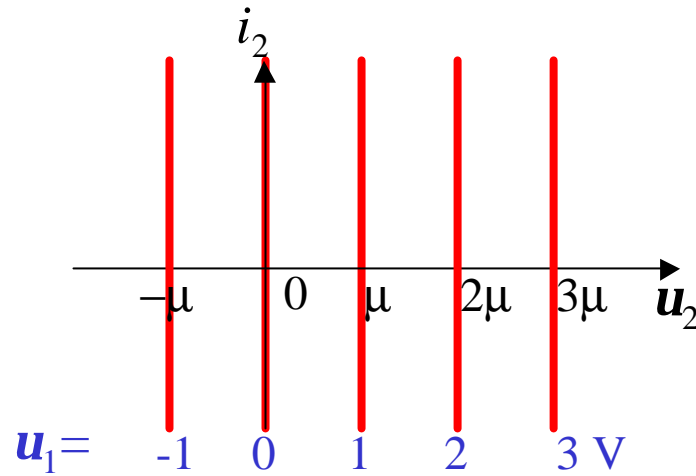
Input characteristics (輸入特性)

i_1 和 u_1 的關係



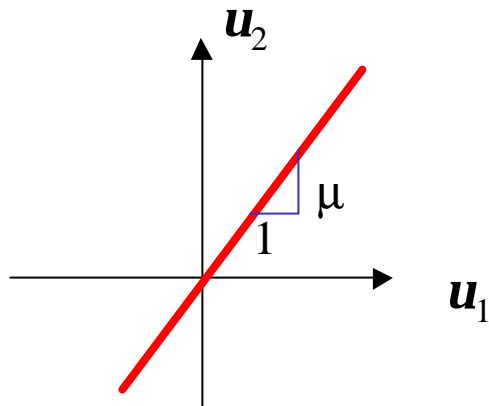
Output characteristics (輸出特性)

i_2 和 u_2 的關係



Transfer characteristics (轉換特性)

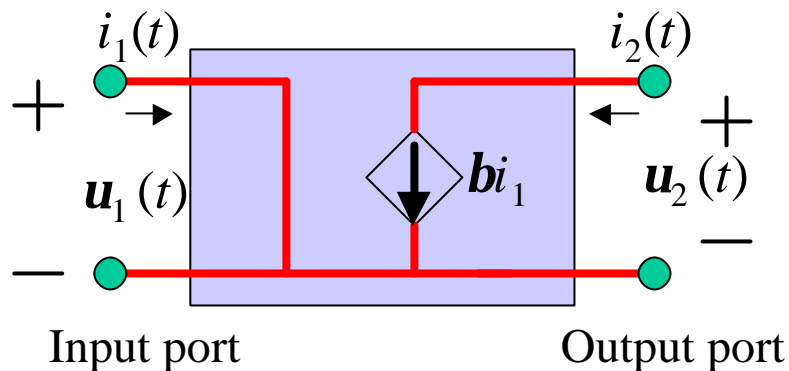
輸出訊號和輸入訊號的關係



可能有四組轉換關係，但並不是每一個都有用

CCCS Current-Controlled Current Source

Current Amplifier



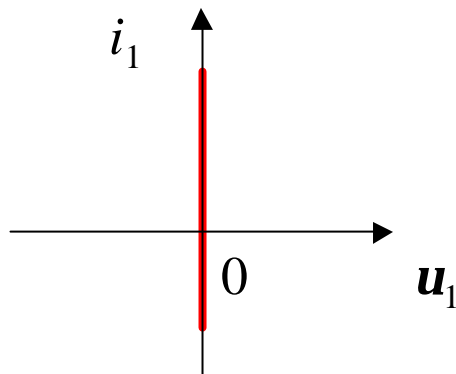
$$u_1 = 0$$

$$i_2 = bi_1$$

b : current gain 電流增益

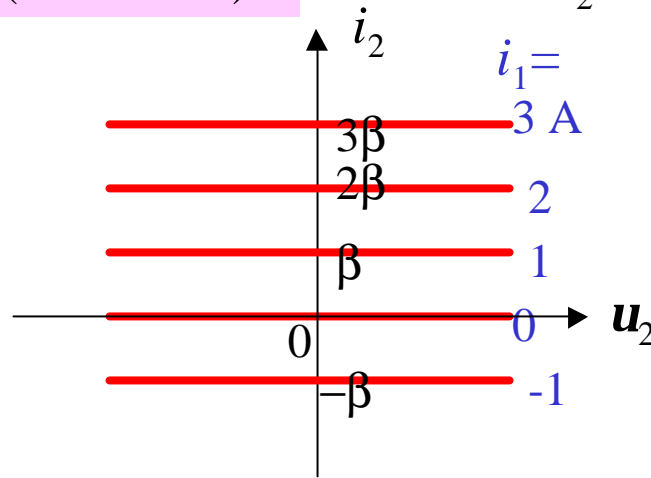
Input characteristics (輸入特性)

i_1 和 u_1 的關係

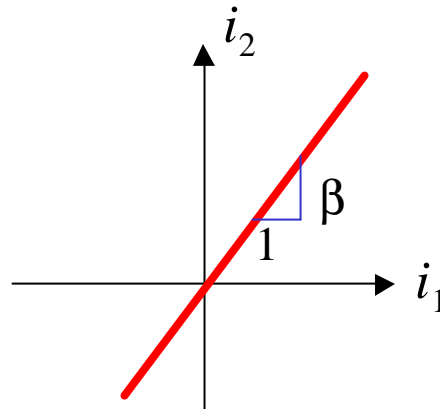


Output characteristics (輸出特性)

i_2 和 u_2 的關係

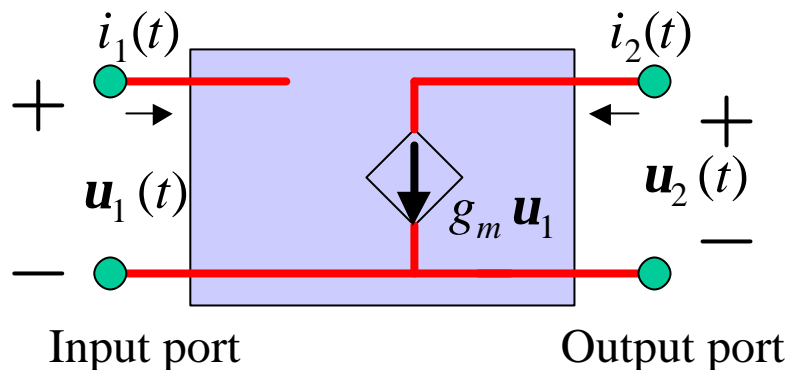


Transfer characteristics (轉換特性) 輸出訊號和輸入訊號的關係



VCCS Voltage-Controlled Current Source

Transconductance Amplifier



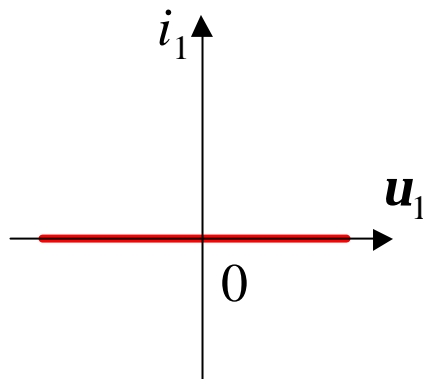
$$i_1 = 0$$

$$i_2 = g_m u_1$$

g_m : transconductance 互導
mutual conductance

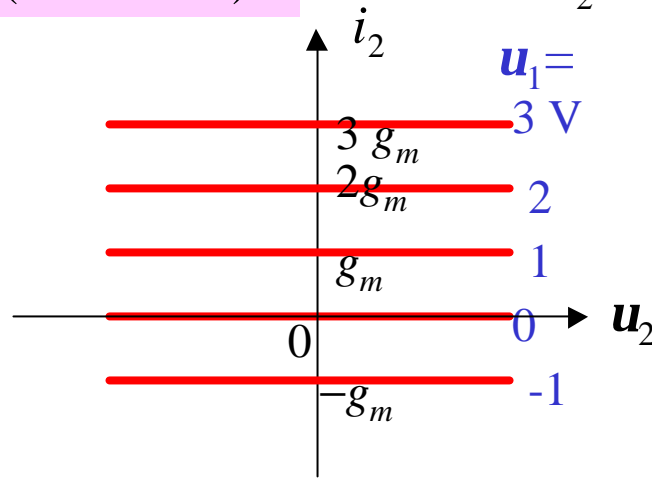
Input characteristics (輸入特性)

i_1 和 u_1 的關係

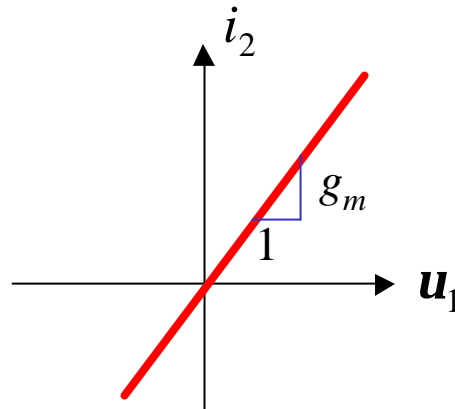


Output characteristics (輸出特性)

i_2 和 u_2 的關係

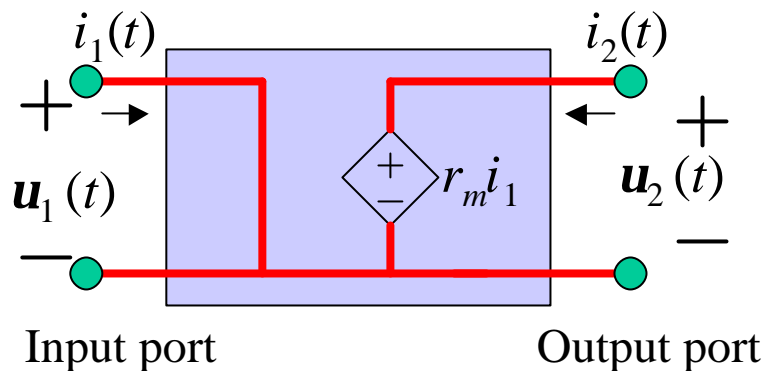


Transfer characteristics (轉換特性) 輸出訊號和輸入訊號的關係



CCVS Current-Controlled Voltage Source

Transresistance Amplifier



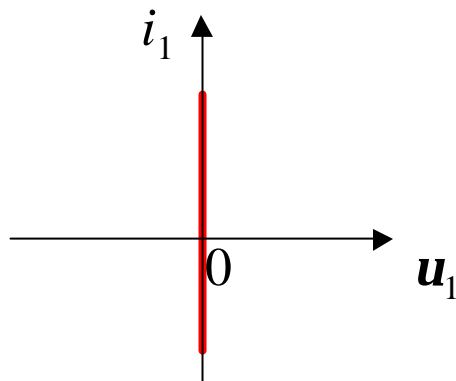
$$u_1 = 0$$

$$u_2 = r_m i_1$$

r_m : transresistance 互阻

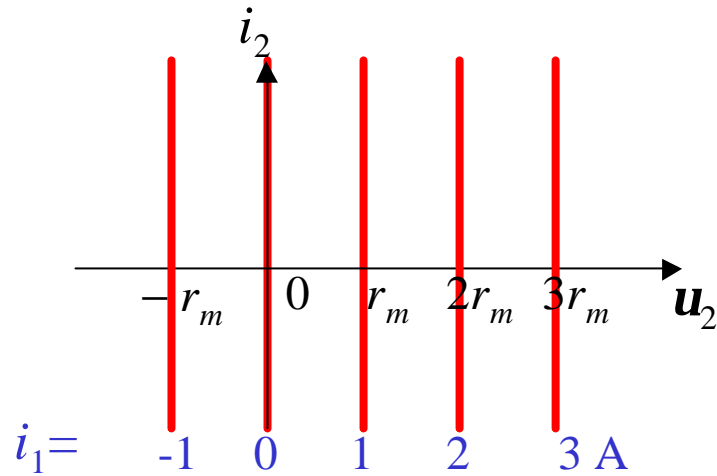
Input characteristics (輸入特性)

i_1 和 u_1 的關係



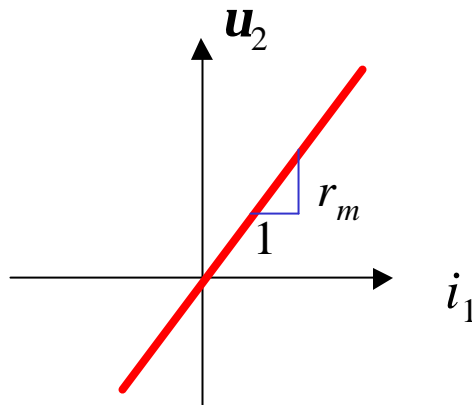
Output characteristics (輸出特性)

i_2 和 u_2 的關係

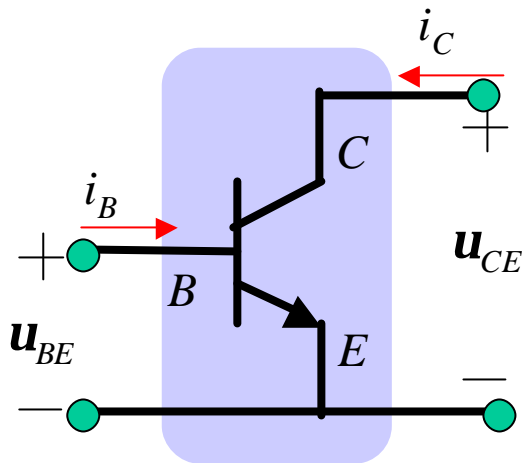


Transfer characteristics (轉換特性)

輸出訊號和輸入訊號的關係

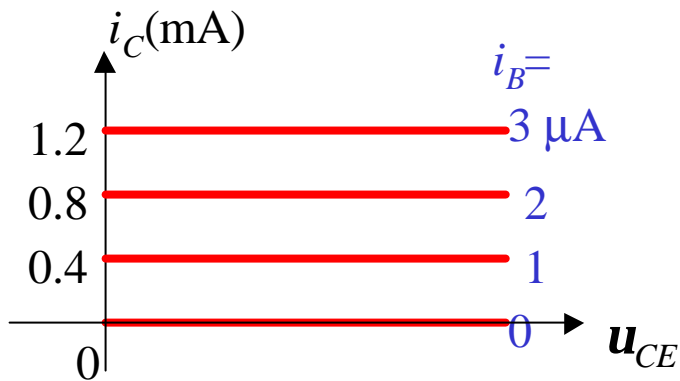
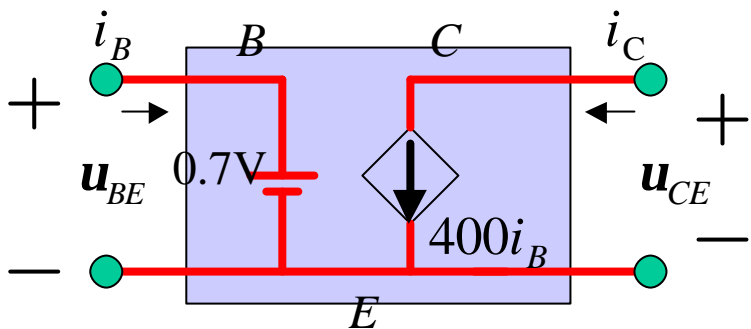
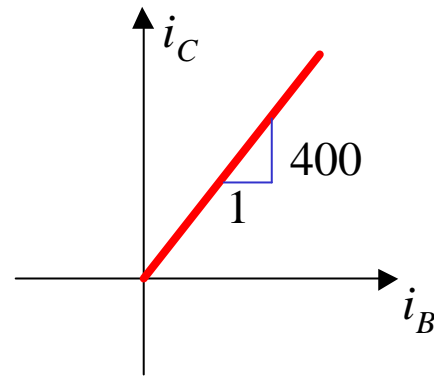
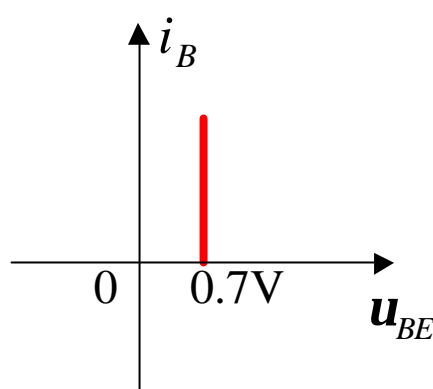


例題 雙極電晶體(BJT)的簡易模型



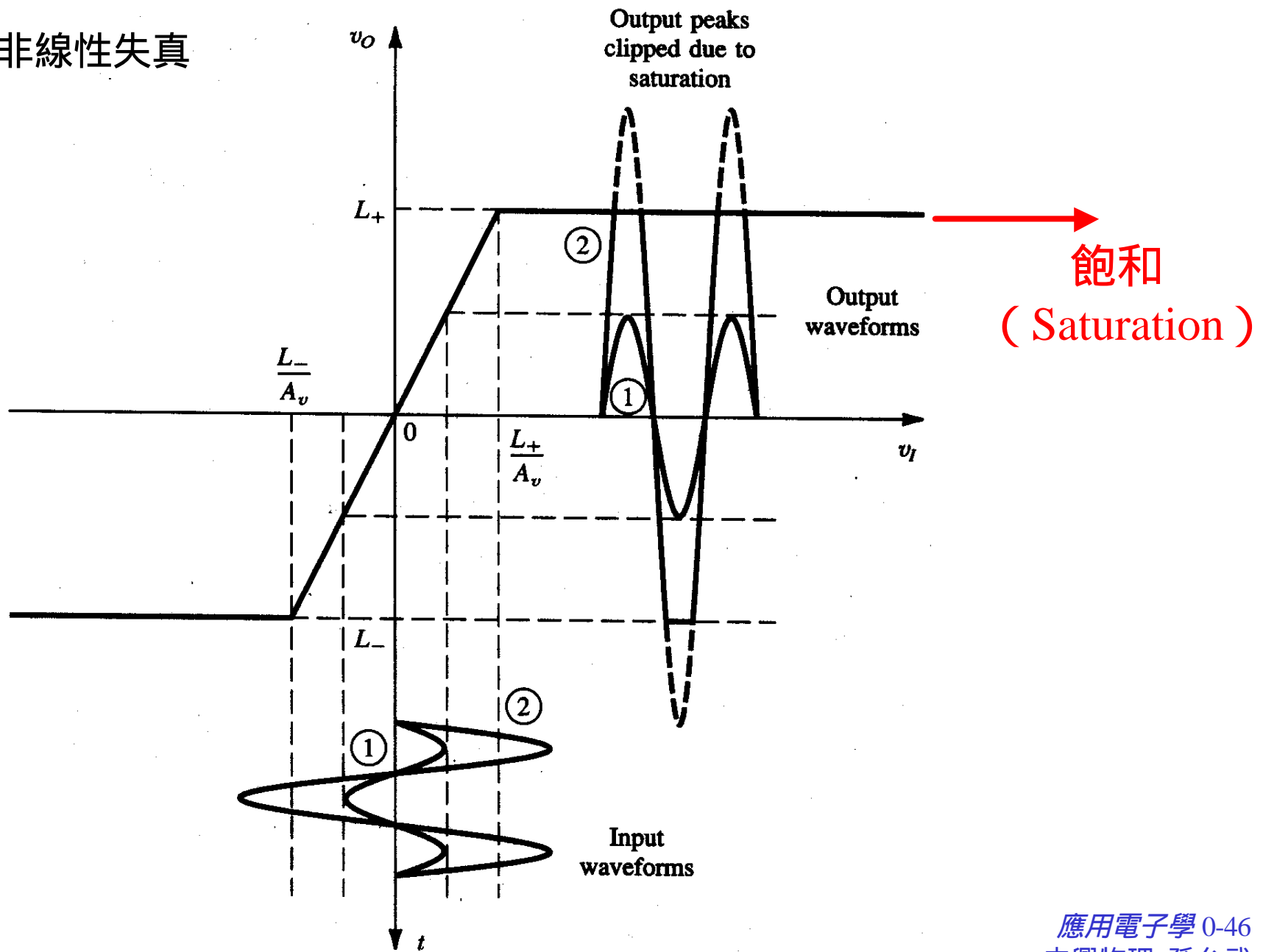
$$u_{BE} = 0.7V \text{ (for } i_B > 0)$$

$$i_C = 400 i_B \text{ (for } u_{CE} > 0)$$



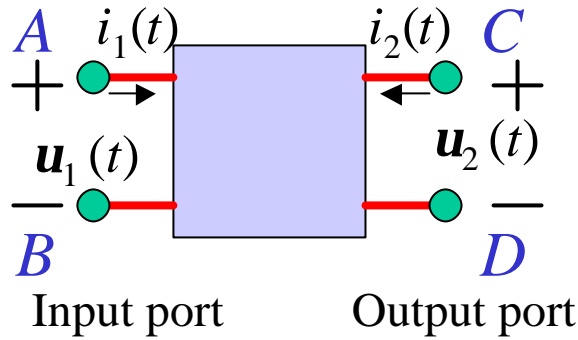
注意適用範圍

非線性失真



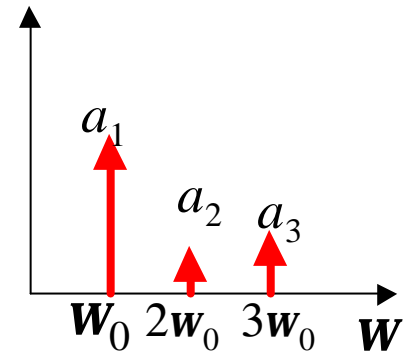
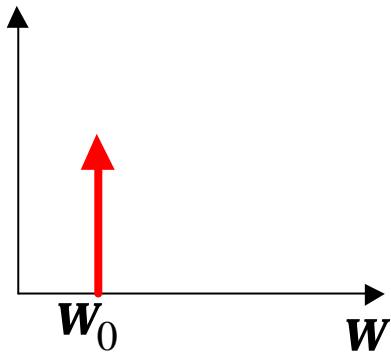
諧波失真

$\cos \omega_0 t$



$$\begin{aligned}
 & a_1 \cos \omega_0 t \\
 & + a_2 \cos(2\omega_0 t + f_2) \\
 & + a_3 \cos(3\omega_0 t + f_3) \\
 & + \vdots
 \end{aligned}$$

諧波失真(harmonic distortion)



THD(total harmonic distortion)

$$\begin{aligned}
 & \sum_{i=2}^{\infty} |a_i|(\text{rms}) \\
 \equiv & \frac{\quad}{|a_1|(\text{rms})} \times 100\%
 \end{aligned}$$