# Chapter 6

# 基本雙極電晶體放大電路

## 6.2 雙極線性放大器

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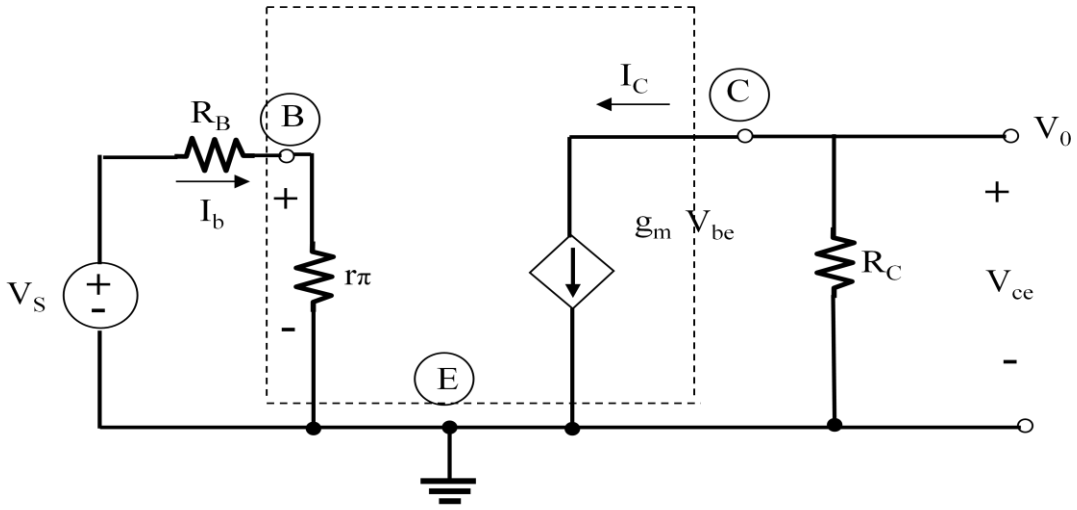
◆ 小訊號混和 π 模型的等效電路




$$i_b = \frac{I_{BQ}}{V_T} v_{be}$$

$$v_{be} = \frac{V_T}{I_{BQ}} i_b$$

定義: $\frac{v_{be}}{i_b} = r_\pi$稱為擴散電阻(Diffusion Resistance)

由上述兩式得$r_\pi = \frac{V_T}{I_{BQ}}$

$$i_c = \left(\frac{\beta}{1+\beta}\right) I_S e^{\frac{v_{be}}{V_T}} = \alpha I_S e^{\frac{v_{be}}{V_T}}$$

$$\frac{\partial i_c}{\partial v_{be}} = \left(\alpha I_S e^{\frac{v_{be}}{V_T}}\right)\frac{1}{V_T} = I_{CQ}\frac{1}{V_T}$$

此時 $\frac{\Delta i_c}{\Delta v_{be}} = I_{CQ}\frac{1}{V_T} = g_m v_{be}$

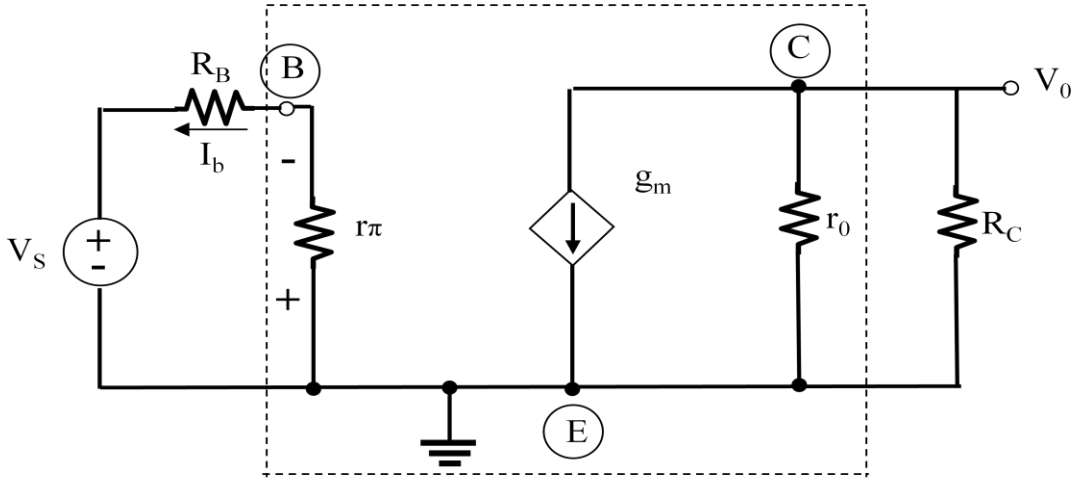
定義: $g_m$稱為轉導(Transconductance)

$i_c = g_m v_{be} = \beta i_b$

$g_m(\frac{v_{be}}{i_b}) = \beta$

$$g_m r_\pi = \beta$$

◆ 含有厄利效應的混成 π 等效電路




在之前章節討論過厄利效應，就是集極電流其實會隨著集極電壓而改變。

$I_C = I_S e^{\frac{v_{be}}{V_T}}\left(1+\frac{V_{CE}}{V_A}\right)$ 其中$V_A$為厄利電壓

$$r_o = \frac{\partial V_{CE}}{\partial I_c}$$

$$\frac{1}{r_o} = \frac{\partial I_c}{\partial V_{CE}} = \frac{\partial}{\partial V_{CE}}\{I_S e^{\frac{v_{be}}{V_T}}\left(1+\frac{V_{CE}}{V_A}\right)\}$$

解出上式即可得$r_o = \frac{V_A}{I_{CQ}}$

將$r_o = \frac{V_A}{I_{CQ}}$定義為小訊號電晶體輸出電阻

(Small − Signal Transistor Output Resistance)