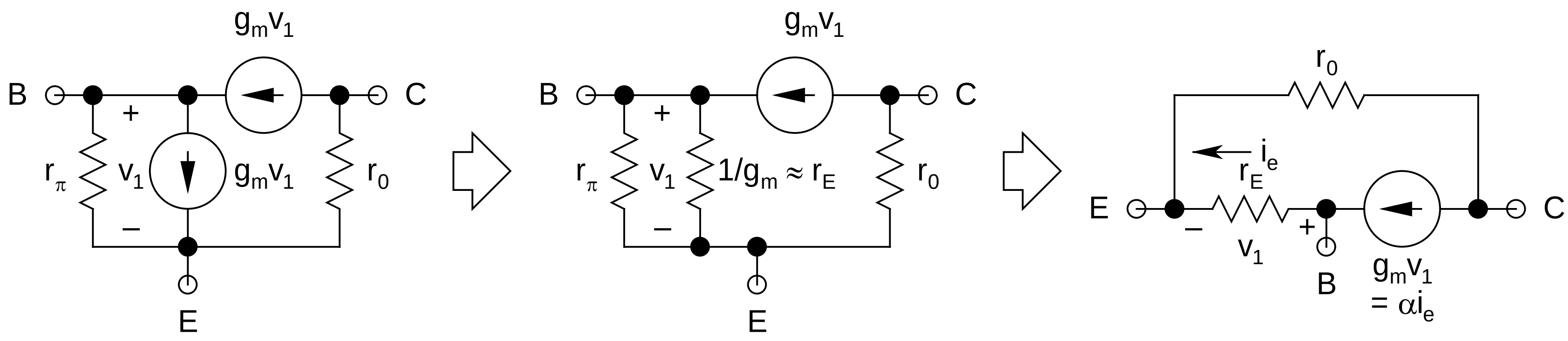
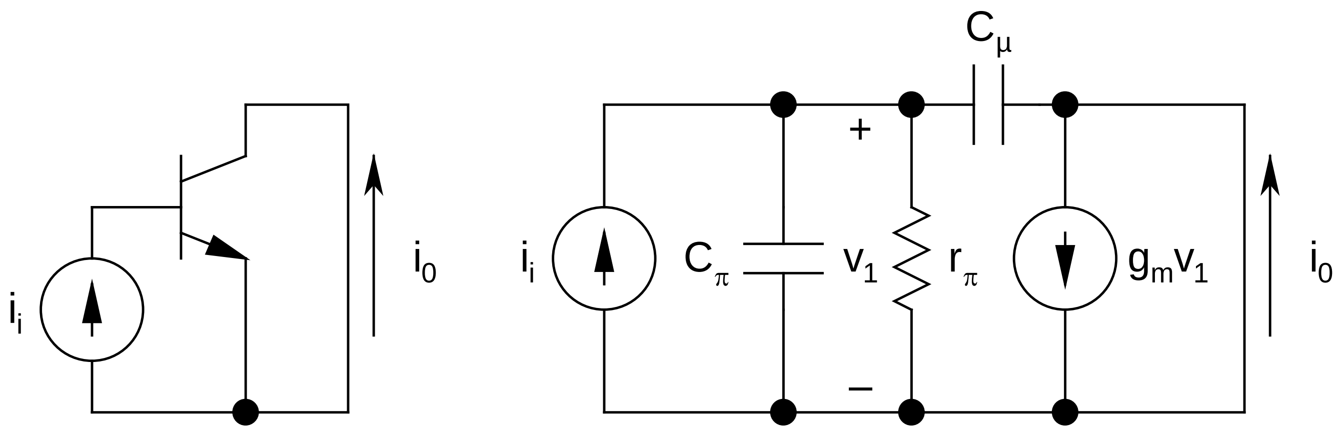
- ***This model is appropriate when the ac input is applied to base***
- ***When the ac input is applied to the emitter, then need to draw this circuit in a slightly different way***



Frequency Specifications of BJTs

- ***Four important characteristic frequencies***:
  - ***Beta Cutoff Frequency*** (f_β)
  - ***Unity Gain Cutoff Frequency*** (f_T)
  - ***Alpha Cutoff Frequency*** (f_α)
  - ***Maximum Operable Frequency*** (f_{max})



- $i_0 \approx g_m v_1$ (***neglecting reverse transmission through C_μ***)
- $v_1 = i_i Z_{eq}$

$$Z_{eq} = \frac{r_\pi}{1 + s r_\pi \left(C_\pi + C_\mu \right)} \qquad \left(s = j\omega \right)$$

- Thus:

$$\beta(j\omega) = \frac{i_0(j\omega)}{i_i(j\omega)} = \frac{\beta_0}{1 + j\omega/\omega_\beta}$$

β_0 (= $g_m r_\pi$): ***Low-frequency short-circuit common-emitter current gain***

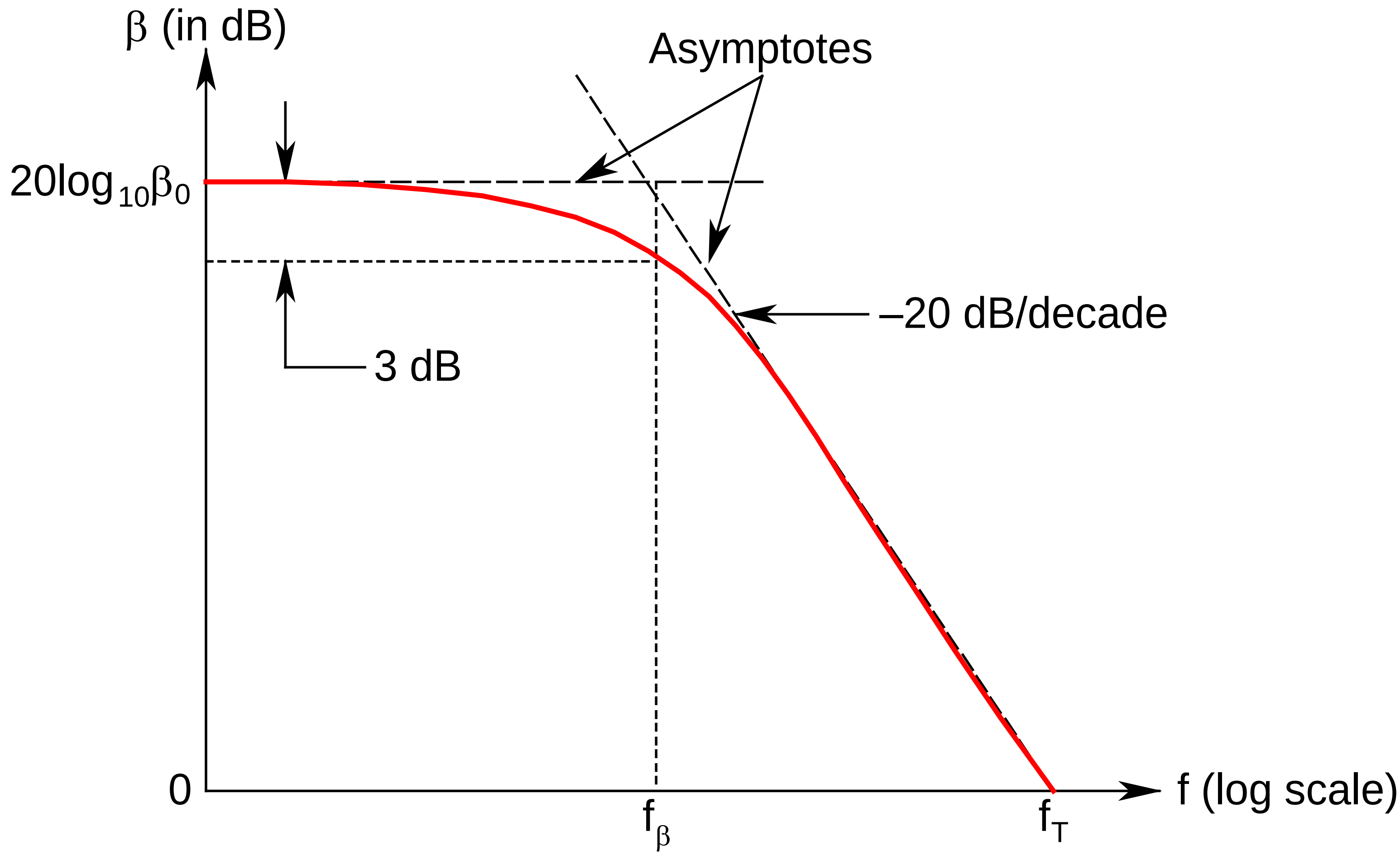
$$\omega_\beta = \frac{g_m}{\beta_0\left(C_\pi + C_\mu\right)}$$

- f_β [= $\omega_\beta/(2\pi)$]: ***Beta Cutoff Frequency***
- At $f = f_\beta$, $\beta = \beta_0/\sqrt{2}$

- For f >> f_β:

$$\beta(j\omega) \simeq \frac{g_m}{j\omega\left(C_\pi + C_\mu\right)}$$

- At $\omega = \omega_T = g_m/(C_\pi + C_\mu)$, $|\beta| = 1$
- f_T [$= \omega_T/(2\pi)$]: ***Unity Gain Cutoff Frequency*** (also known as ***Unity Gain Bandwidth***)
- **Note**: $f_T = \beta_0 f_\beta$
- ***$f_T > f_\beta$, and their spacing depends on β_0***



β (in dB)
Asymptotes
20log10β0
–20 dB/decade
3 dB
0
fβ
fT
f (log scale)