Small-Signal Models

Electrical Engineering

Linearising a transistor around its bias point, and what transconductance actually is.

Around a bias point a nonlinear device behaves linearly, described by its transconductance.

BJT: $g_m = I_C/V_T$ · FET: $g_m = 2I_D/V_{ov}$

$I_C = 1$ mA — **$g_m \approx 38$ mS**

1 mA ÷ 26 mV.

$\beta = 100$ — **$r_\pi \approx 2.6$ kΩ**

$\beta \div g_m$.

$R_C = 1$ kΩ — **Gain ≈ −38**

Bias sets gain.

THE COMMON MISTAKE

× **Using the small-signal model for a large swing**

✓ **Keeping the signal well below the bias**

The model is the first term of a Taylor expansion. Drive it hard and the terms you dropped return as distortion and clipping.

To draw the small-signal circuit, kill the DC: supply rails become ground and bias current sources become open circuits.