The Small-Signal Equation Matrix

We can summarize our small-signal equations with the small-signal equation matrix. Note this matrix relates the small-signal BJT parameters v_{be} , i_b , i_c , and i_e .

Column Parameters

 V_{be}

$$g = \frac{\beta}{g_m}$$

$$\frac{1}{g_m}$$

$$r_e = \frac{\alpha}{g_n}$$

Row Parameters

 $r_{m} = \frac{\beta}{g_{m}}$ $r_{m} = \frac{\beta}{g_{m}}$ $r_{m} = \frac{\alpha}{g_{m}}$ $r_{m} = \frac{\alpha}{g_{m}}$

 $rac{i_e}{r_a} = \frac{g_m}{\alpha}$ $\beta + 1$ $rac{1}{\alpha} = \frac{\beta + 1}{\beta}$ 1

Here's how you use this

To use this matrix, note that the **row parameter** is equal to the product of the **column parameter** and the **matrix element**. For example:

$$i_b = \frac{1}{r_\pi} V_{be}$$

 V_{be}

 $oldsymbol{v}_{be}$ 1 $oldsymbol{r}_{\pi}=rac{oldsymbol{eta}}{oldsymbol{g}_{m}}$ $oldsymbol{1}_{oldsymbol{g}_{m}}$ $oldsymbol{r}_{e}=rac{lpha}{oldsymbol{g}_{m}}$

 $\frac{i_b}{r_m} = \frac{g_m}{\beta} \qquad 1 \qquad \frac{1}{\beta} \qquad \frac{1}{(\beta+1)}$

 $\frac{i_c}{g_m}$ β 1 $\alpha = \frac{\beta}{\beta + 1}$

 $\frac{1}{r_e} = \frac{g_m}{\alpha}$ $\beta + 1$ $\frac{1}{\alpha} = \frac{\beta + 1}{\beta}$