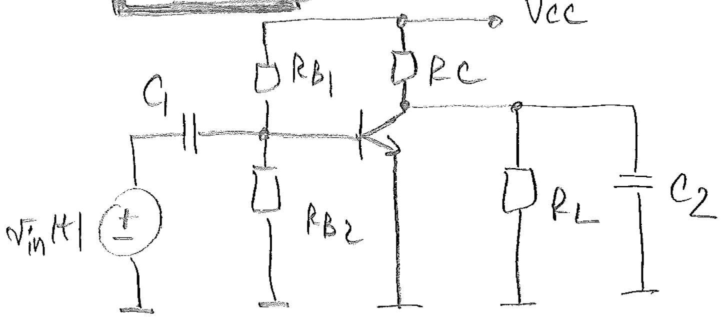
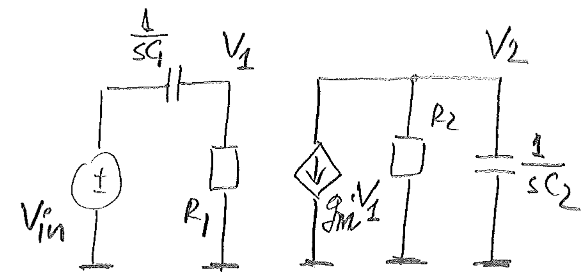
Example



$\Rightarrow$ small signal analysis



where: $\begin{cases} R_1 \triangleq R_{B1} \| R_{B2} \| r_\pi \\ R_2 \triangleq R_C \| R_L \end{cases}$

$$\begin{cases} \dfrac{V_{in} - V_1}{\frac{1}{sC_1}} = \dfrac{V_1}{R_1} \Leftrightarrow sC_1 V_{in} = V_1(sC_1 + G_1) \Rightarrow \boxed{\dfrac{V_1}{V_{in}} = \dfrac{sC_1}{sC_1 + G_1}} \\ g_m V_1 + \dfrac{V_2}{R_2} + \dfrac{V_2}{\frac{1}{sC_2}} = 0 \Rightarrow \boxed{g_m V_1 = -V_2(sC_2 + G_2)} \end{cases}$$

$\Rightarrow$ eliminate V_1

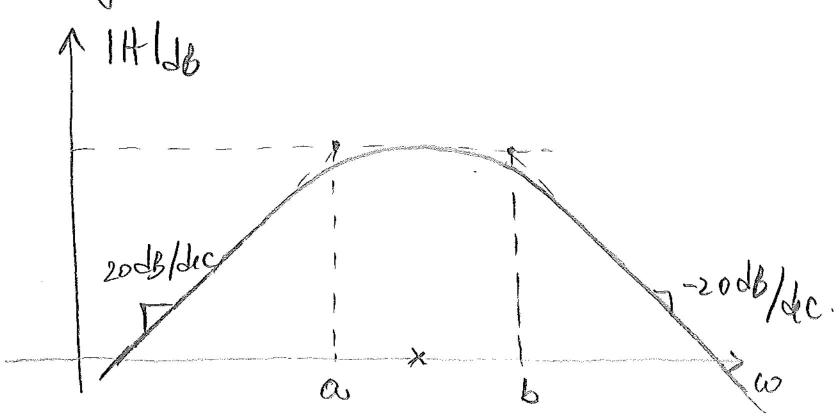
$$\Rightarrow H(s) = \frac{V_2}{V_{in}} = -\frac{sC_1 \cdot g_m}{(sC_1 + G_1)(sC_2 + G_2)}$$

$$\boxed{H(s) = \frac{-\frac{g_m}{C_2} \cdot s}{\left(s + \frac{G_1}{C_1}\right)\left(s + \frac{G_2}{C_2}\right)}}$$

of the form: $\boxed{H(s) = \dfrac{-K \cdot s}{(s+a)(s+b)}}$

Assume: $a < b$, $a, b > 0$, $K > 0$

Magnitude Bode diagram:



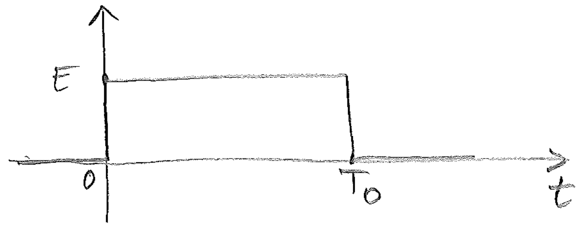
$$\boxed{H(j\omega) = \frac{-k\, j\omega}{(j\omega + a)(j\omega + b)}}$$

$\omega \to 0$: derivator

$\omega \to \infty$: integrator

- Consider the response to this signal:

$$v_{in}(t) = E\,[u(t) - u(t-T_0)]$$



$$v_{in}(t) \to \boxed{H(s)} \to v_2(t)$$

$$V_{in}(s) = E\left(\frac{1}{s} - \frac{1}{s}e^{-sT_0}\right) = \frac{E}{s}\left(1 - e^{-sT_0}\right)$$

$$\boxed{V_2(s) = H(s)\cdot V_{in}(s)} = \underbrace{\frac{E}{\cancel{s}}\left(1-e^{-sT_0}\right)}_{=V_{in}(s)} \cdot \underbrace{\frac{-k\cancel{s}}{(s+a)(s+b)}}_{=H(s)}$$

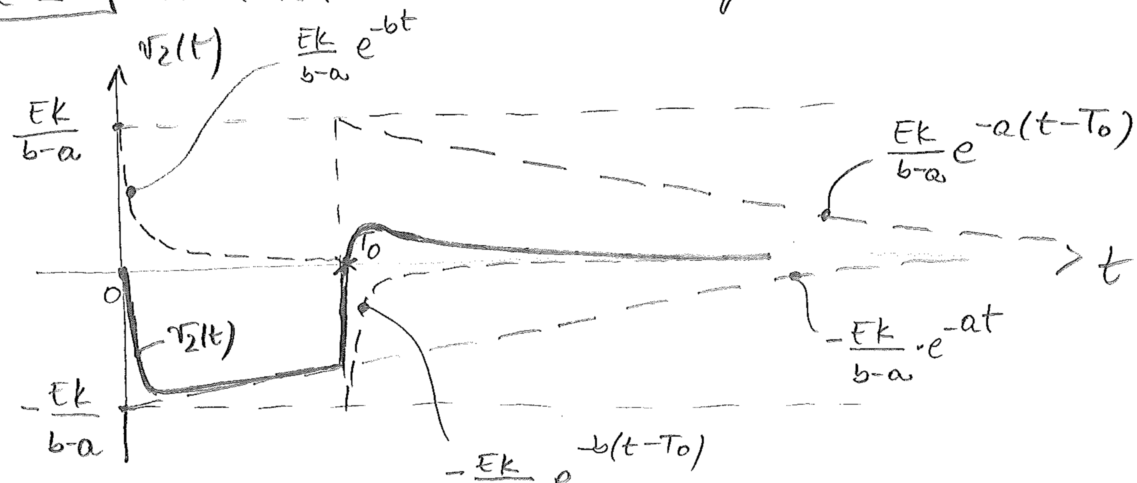
↑ take it separately:

$$H(s) = \frac{-k}{(s+a)(s+b)} = \frac{-\frac{k}{b-a}}{s+a} + \frac{-\frac{k}{a-b}}{s+b} = -\frac{k}{b-a}\left[\frac{1}{s+a} - \frac{1}{s+b}\right]$$

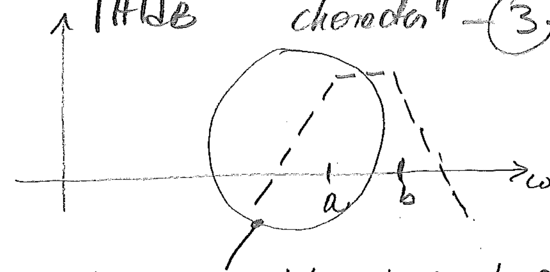
$$\Rightarrow\; V_2(s) = -\frac{Ek}{b-a}\cdot\left(1 - e^{-sT_0}\right)\cdot\left(\frac{1}{s+a} - \frac{1}{s+b}\right)$$

$$\Rightarrow\; \boxed{v_2(t) = \underbrace{-\frac{Ek}{b-a}\left[e^{-at} - e^{-bt}\right]\cdot u(t)}_{} + \underbrace{\frac{Ek}{b-a}\left[e^{-a(t-T_0)} - e^{-b(t-T_0)}\right]u(t-T_0)}_{}}$$

$\boxed{\text{case 1}}$ Assume: $a \ll b \Rightarrow$ large bandwidth!

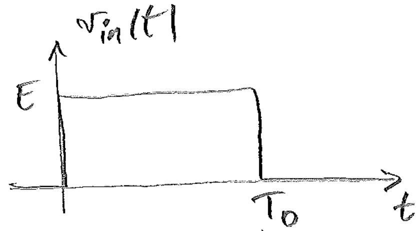


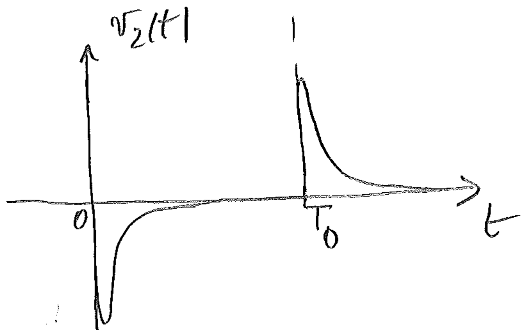
$\boxed{\text{NOTE}}$: $a \to 0$ $b \to \infty$ output will look like input! (with minus) "derivator character"

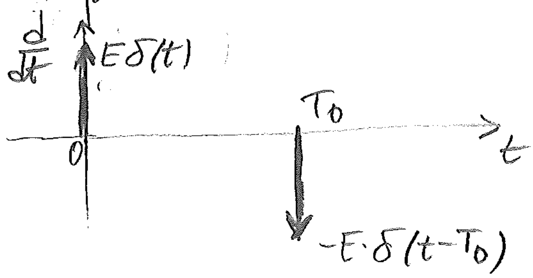


Looks more like derivator!
Hence output will look more like:

Case 2 a, b both very large:

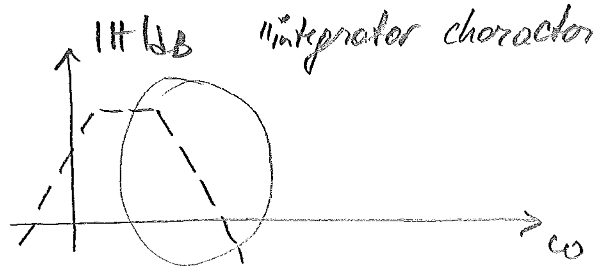






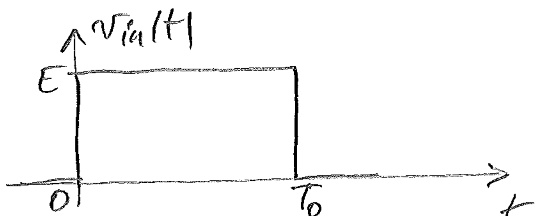
: $\boxed{\text{ideal}}$

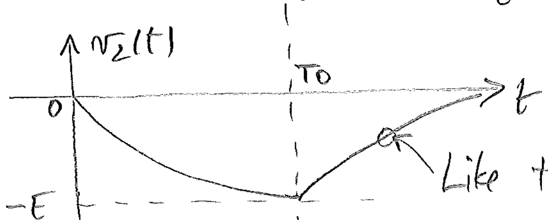
"integrator character"



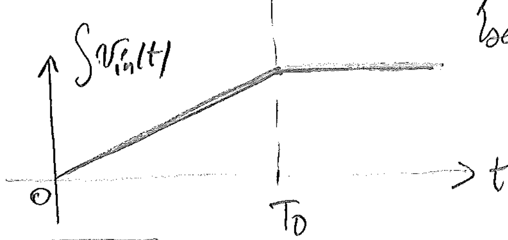
Looks more like integrator!
So, output:

Case 3 a, b both very small:





Like this because there is part of the spectrum where the circuit does not behave like an (ideal) integrator!



: $\boxed{\text{ideal}}$

QUESTION: what is output for input: